Chino Mines Administrative Order on Consent Ecological Risk Assessment for the Smelter Tailings Soil Investigation Unit

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

1.0 INTRODUCTION AND PURPOSE

This document presents the results of the Ecological Risk Assessment (ERA) for the Smelter-Tailings Soils Investigation Unit (S/TSIU) at the Chino Mine Investigation Area, Grant County, New Mexico (the site). The Chino Mine site, located approximately 12 miles southeast of Silver City, includes open pit copper mining facilities, rock stockpiles, leach stockpiles, mineral processing facilities, and tailings impoundments (Figure 1.0-1). Chino Mines Company (CMC) controls approximately 116,000 acres around the mining and mineral processing facilities.

In December 1994, CMC and the New Mexico Environment Department (NMED) entered into an Administrative Order on Consent (AOC) to conduct environmental investigations at the Chino Mine site and surrounding area as appropriate. The AOC requires that a Remedial Investigation/Feasibility Study (RI/FS), including human and ecological risk assessments (ERAs), be completed for each of the following Investigation Units (IUs):

- Lambright Draw;
- Hanover Creek Channel;
- Whitewater Creek Channel;
- Smelter;
- Hurley Soils; and
- Tailings Impacted Soils.

For practical and logistical reasons, the Hanover Creek and Whitewater Creek IUs, and the Smelter IU and Tailing IUs have been combined for performing the RI/FS investigations. To date, the RI/FS investigation is complete for only the Hurley Soils IU.

CMC and NMED agreed to conduct a baseline ERA (BERA) for the combined IUs based on suggestions that an ERA could be more effectively conducted on a site-wide basis. An Ecological IU was designated for this purpose and added to the AOC in December 1995 (NMED 1995). The Ecological IU encompasses areas of the other IUs that may contain ecological resources and may be affected by contaminant release (NMED 1995).

The sitewide BERA, completed in February, 2006 was conducted in accordance with United States Environmental Protection Agency (USEPA) guidance for ERAs at Superfund (Comprehensive Environmental Response, Compensation and Liability Act of 1980 [CERCLA]) sites (USEPA 1992, 1997). While the Chino site is not a Superfund site, the intent of the AOC is to produce CERCLA-like investigations and remedies. More recent general guidance on conducting ERAs (USEPA 1998) was also used in planning, terminology and the risk characterization approach of the BERA.

The sitewide BERA focused on areas of the site that may have been affected by historical release of contaminants from mining and milling operations. In accordance with the AOC, entered into by CMC and the New Mexico Environment Department (NMED) in December, 1994, current potential sources that are operated under state or federal permits would not be considered in the risk assessment process, but areas affected by historical releases occurring from the sources prior to permitting are to be addressed if data from the RIs indicate contamination.

Because the RI/FS investigations were not complete at the time of the BERA completion, the nature and extent of contamination in the IUs had not been fully characterized. Therefore, the BERA design was focused on identifying chemicals of potential concern (COPCs) for ecological receptors, characterizing stressor-response relationships for key COPCs, and developing risk-based tools for further evaluating ecological risk in individual IUs as more complete nature and extent characterization become available from RI/FS investigations. As described in Section 1 of the sitewide BERA Report (NewFields 2005), and detailed in Technical Memorandum No. 1 (TM-1) (Schafer 1999a), the Chino ERA study design was based on assessing risk along a gradient of contamination, indicated by soil copper concentrations and pH described in the baseline remedial investigation (BRI) (CMC 1995). The tools provided in the sitewide BERA allow for a streamlined ERA approach for assessing each IU as additional RI/FS data become available.

The sitewide BERA included evaluation of data from the S/TSIU area, including samples collected during the Background Remedial Investigation (BRI) (CMC 1995), and the BERA field effort as part of the Ecological Remedial Investigation (ERI) (Arcadis JSA 2001). This document extends the analysis to include more recent data collected in the S/TSIU Remedial Investigation (RI) report (SRK 2006). The RI was conducted to more fully characterize the nature and extent of contamination in the S/TSIU, and to fill spatial data gaps identified from the ERA by human health risk assessors. The additional data provided in the RI is limited to soils, sediment, and surface water data. No additional biological data were collected. The S/TSIU is assumed, in this document, to include all areas extending from the northern portions of Bayard (Figure 1.0-1) south to the southern AOC boundary and west from the western AOC boundary east to Lampbright Draw. The S/TSIU does not include those areas that are part of the Hurley Soils IU, Hanover and Whitewater Creek IU, Lampbright Draw IU or the operational areas of the site.

1.1 Summary of Problem Formulation

A full problem formulation discussion is presented in the sitewide BERA Report (NewFields 2005) and TM-1 (Schafer 1999a). A detailed discussion of the site setting and history is provided in the S/TSIU RI report (SRK 2005).

The potential chemical stressors at the site consist primarily of metals, associated inorganics (e.g., sulfate) and acidic pH. The sitewide BERA identified potentially complete exposure pathways that were used to evaluate the risk of direct effects on ecosystem components from chemical stressors associated with the site. The sitewide BERA also noted that indirect effects of components of the ecosystem that are not directly affected by exposure to chemical stressors can result from habitat effects to ecosystem components that may have been directly affected by exposure (e.g., a loss of nesting sites or prey base may have an effect on raptor populations even if the exposure to raptors is not predicted to be at a level of concern).

The potentially complete exposure pathways used to guide the sitewide BERA are shown in a conceptual site model (CSM) shown in Figure 1.1-1, and is unchanged from the CSM used in the sitewide BERA.

1.1.1 Site Description

Major topographic features in the AOC investigation area include the Cobre Mountains and the San Vicente Basin. Erosion of the plateau surface in the Cobre Mountains southeast of Bayard has resulted in a series of even-crested, southward-sloping ridges that gradually become low hills. The topographic high within the AOC investigation area is approximately 7,700 feet.

The San Vicente basin is a broad lowland that extends northward from the Mimbres Valley. The basin terminates against the Big Burro and Little Burro Mountains on the west, Silver City and Pinos Altos ranges on the north, and the Cobre Mountains on the east. The slope of the terrain is from these mountains toward the San Vicente Arroyo. The San Vicente Basin is characterized by several dry, sandy washes and gullies. Elevations in this area of broad plains range from about 5,700 feet near Hurley to 4,500 feet at the confluence of Whitewater Creek with the San Vicente Arroyo.

The geology of the S/TSIU is described in detail in the S/TSIU RI. The soils in the S/TSIU are largely derived from non-mineralized sources such as volcanic tuffs and the Gila conglomerate. The leachate from these sources is essentially free of trace metals and maintains a circumneutral pH; however, the buffering capacity is minimal because carbonate content is low (Golder 2000).

Mesquite/mixed-grama shrubland occupies the most area in the S/TSIU east of Whitewater Creek and the tailing impoundments (Figure 1.1-2). Mountain mahogany shrubland occupies higher elevations (above about 6,000 amsl) on the south-facing slopes in the northern sections of the IU. The mixed-grama herbaceous alliance is the most extensive west of Whitewater Creek and southwest of the tailing impoundments. Fluvial forest shrubland is the dominant type along ephemeral and intermittent drainages and represents the riparian community in the study area.

CSMs have been used to describe the Chino Mine site in several documents (CMC 1995; Schafer 1999a, 1999b; Golder 2000). For upland areas, the primary contaminant sources and release mechanisms are the smelter emissions and windblown tailing (Figure 1.1-1). Prevailing winds tend to be from the northwest (CMC 1995). Therefore, soils in areas to the south and east of the smelter and the tailing impoundments are likely to be most affected by dryfall from these aerial sources, although surface topography may have affected specific distribution of dryfall in the S/TSIU.

Following airborne deposition onto soils, metals and other inorganic constituents may be further redistributed by a combination of physical (air and water erosion) and/or chemical (leaching) processes. Although the ephemeral drainages east of Whitewater Creek may have been directly affected by dryfall, another effect on the drainages may be the downgradient erosional transport of affected soils and tailing into the drainages. Through this mechanism, COPCs could concentrate in fine materials deposited on soils along the drainages, as well as in the active channel sediments.

Prior to construction of the Whitewater Creek diversion into Bolton Draw, the aerial deposition pathways described above were the primary routes of transport of COPCs into the S/TSIU. Construction of the diversion may have introduced the potential for surface water flow and fluvial transport of sediments from Whitewater Creek into the S/TSIU. However, the construction included a surface water impoundment in James Canyon at the upstream end of the diversion. The impoundment captures sediment from upstream reaches of Whitewater Creek and, to date, surface water flow into Bolton Draw occurs only occasionally. Therefore, fluvial transport of COPCs into the S/TSIU from the Hanover-Whitewater Creek IU appears to be minimal, and has not been important as a historical source. All of the data used in the sitewide BERA were collected prior to construction of the diversion. Data collected for the S/TSIU RI were collected after the diversion was constructed.

1.1.2 Assessment Endpoints

Assessment endpoints are explicit expressions of the ecological resource to be protected (USEPA 1992, 1997, 1998). The BERA process identified a set of assessment endpoints based on ecological relevance, potentially complete exposure pathways, taxonomic groups that may be sensitive to chemical stressors and are potentially exposed as well as site management goals (Schafer and Associates1999a).

Risk questions are described by USEPA (1997) as the questions the ERA will attempt to answer regarding whether or not assessment endpoints could be adversely affected by exposure to COPCs. They form the basis for identifying the specific analyses to be conducted and the data needed to perform the analysis. In some cases, risk questions may be stated as risk hypotheses (USEPA 1998) that form the basis for identifying the data collection and analysis to be performed. Evaluation of risk hypotheses is not equivalent to formal statistical tests of null hypotheses (USEPA 1998).

The endpoints and risk questions used to guide the development of the sitewide BERA are presented in Table 1.1-1. The assessment endpoints can be broken down into three main categories with subcategories as follows:

Terrestrial Vegetation as Wildlife Habitat

- Upland community
- Community of ephemeral drainages

Terrestrial Wildlife

- Herbivorous, insectivorous and omnivorous birds
- Raptors
- Herbivorous, granivorous and omnivorous small mammals
- Ruminants
- Mammalian predators

Aquatic Receptors

- Amphibians
- Aquatic invertebrate and fish community

1.1.3 Sitewide BERA Conclusions

As noted above, the sitewide BERA study design was based on assessing risk along a gradient of contamination, indicated by soil copper concentrations and pH described in the BRI (CMC 1995). The sitewide BERA assessed potential risks to each of the assessment endpoints at the CMC site. Varying levels of risk of adverse effects were identified for several assessment endpoints/receptors evaluated in the sitewide BERA. The conclusions reached in the sitewide BERA regarding potential risks are summarized below:

1) Metal concentrations have apparently been increased, and soil pH decreased, by site operations in some areas of the site; concentrations are most elevated in surface soils;
2) Because the bioavailable fraction of metals is also increased due to the depressed soil pH, metal exposure is also apparently increased;
3) A wide range of exposure conditions exist at the site, corresponding to both elevated metal concentrations and depressed pH; and
4) A wide range of exposure conditions exist in a demonstrable gradient with distance from the smelter and tailing impoundments (especially to the southeast of the smelter and the old Lake One area).

Vegetation

Overall trends identified from results of the sitewide BERA analysis indicated that:

1) Phytotoxicity testing using standard test species (alfalfa and perennial ryegrass) and site soils collected along the gradient showed significant toxicity in site soils collected from most heavily contaminated locations. Toxicity increased with metal concentrations and inversely with pH. Sites most distant from the smelter showed low, or no toxicity; and
2) Differences in upland vegetation community structure and composition varied along the gradient; locations closest to the sources and containing the highest concentrations tended to have lower richness and cover than areas further from the sources.

Toxicity testing results were applicable to both upland and ephemeral drainage communities. Ephemeral drainages tended to have richness and cover similar to that of the upland reference areas. However, communities may not be comparable because of the wide range of conditions among ephemeral drainages. The lack of suitable reference areas representative of riparian vegetation communities unaffected by mining operations is a source of uncertainty in the risk assessment.

The stressor response analysis presented in the sitewide BERA evaluated whether the potential exposure to terrestrial plants from site soils was correlated with the effects on community structure and (laboratory-based) phytotoxicity. The analysis indicated that a measure of available copper was the best overall predictor of field and laboratory vegetation response variables. Bioavailable copper, as measured by cupric ion activity [pCu^{2+}], was identified as the risk driver for potential effects to terrestrial vegetation in the sitewide BERA. Several measurement endpoints including community species richness, total canopy cover, stem weight and length (laboratory studies), and root weight and length (laboratory studies) were more highly correlated with pCu^{2+} than with any other measure of metal concentration (Table 1.1-2). For other measures including seedling emergence, survival and the number or rhizobium containing root modules (alfalfa) were more highly correlated to soluble forms of copper, but in all cases pCu^{2+} was one of the most highly correlated values for those measures as well.

The pCu^{2+} of the soil was highly predictable from soil pH and total copper concentration. The models derived in the sitewide BERA are presented in Table 1.1-3 along with the r-squared values from the regression analyses used to create the models. To help guide the vegetation risk characterization, pCu^{2+} levels corresponding to a range of effects were identified based on graphical analysis. The level of cupric ion activity is expressed as the negative logarithm of the activity, similar to the way in which hydrogen ion activity is expressed as pH. Therefore, higher pCu^{2+} values indicate *lower* activity, and lower pCu^{2+} values indicate *higher* activity. Higher activity is associated with greater risk of toxicity.

Two benchmarks for vegetation risk, both based on site-specific measurements of laboratory toxicity and metrics of the vegetation community, were identified for use in screening and preliminary delineation of areas where effects related to exposure to site contaminants are expected: a *de minimis* (i.e., negligible) effects level (DEL; pCu^{2+} > about 6 or 7) above which no ecologically significant adverse effects are expected, and a probable effects level (PEL; $pCu^{2+} \leq 5$) below which the detection of adverse effects is considered probable. Adverse effects are possible for pCu^{2+} values between the DEL and PEL, but the ecological significance of such effects is less certain.

The sitewide BERA concluded that the combination of elevated copper and depressed pH, as expressed by the pCu^{2+} measure, have led to higher risk of phytotoxicity for some areas of the Chino Mine site, particularly those areas closest to the smelter and tailings impoundments such as ERA01, 02, 03 and 07. The effects are highly dependant on soil pH since some locations (ERA11, 12, 13, 14 and 15) had elevated copper concentrations, but due to relatively high pH exhibited little or no evidence of phytotoxicity in field measurements and/or laboratory exposure studies. The sitewide BERA acknowledges that other factors including slope, aspect, elevation, soil type and historic cattle grazing all may have some effect on the community structure and overall quality of the vegetation at the sites evaluated in the assessment. However, the weight-of-evidence presented in the sitewide BERA clearly indicates a correlation between elevated concentrations of available copper, based on elevated total soil copper concentrations and depressed pH, and potential and actual deleterious effects to the vegetation community as they relate to wildlife habitat quality.

The sitewide BERA also indicated that COPCs other than copper could contribute to toxicity under low pH conditions, including cadmium, lead and zinc which are also elevated at some locations. Additionally, non-site COPCs such as aluminum and manganese could also be toxic when present at natural concentrations in soils where pH is less than 5.0. Physical conditions and historic land use (i.e., cattle grazing) also affect vegetation at the site and could be responsible for some of the variability observed in the plant communities, and could also affect overall wildlife habitat quality.

<u>Terrestrial Wildlife</u>

A detailed assessment of exposure and risks for terrestrial wildlife receptors was provided in the sitewide BERA. The conclusions drawn indicate that potentially significant risks to wildlife receptors appear to be relatively restricted to the most contaminated areas of the site, immediately east of the smelter and northernmost tailings impoundments (within the S/TSIU) and at some locations along the Hanover and Whitewater Creek corridor (some of which is within the S/TSIU). Risks to small ground-feeding birds appeared to be of potentially greatest concern based on risk from copper intake from ingested soils and food, as well as cumulative risk from intake of other COPCs. Risk to small mammals was of second-greatest concern, but was substantially less than that estimated for ground-feeding birds based on the magnitude of hazard quotients. Individuals of larger and more mobile receptors such as ruminants, mammalian predators and raptors appeared to be at relatively low risk. Overall, the sitewide BERA indicates that local populations inhabiting the AOC or within sub-areas of the AOC could be affected. No effects to regional populations of wildlife were predicted.

The sitewide BERA provided a range of soil screening levels (SSLs) for use in assessing copper risk to the small ground-feeding bird receptor. These values are utilized in the S/TSIU document. In addition, S/TSIU risk estimates are provided for all COPCs evaluated in the receptor-specific detailed analysis portion of the sitewide BERA. The exposure models and toxicity reference values (TRVs) used in the sitewide BERA are unchanged in this risk assessment.

<u>Aquatic Life</u>

Little surface water and sediment data were available for use in the sitewide BERA. The report generally concluded that potential risks from cadmium, copper, lead and zinc concentrations in surface water and sediment were predicted along the Whitewater Creek corridor which is in the Hanover Whitewater Creek IU, and in Bolton Draw which is in the S/TSIU. The habitat in these areas is limited by low flows and frequent absence of water. Therefore the aquatic communities in these areas are limited, and typical of ephemeral aquatic habitats in desert southwest.

Stock tanks in the S/TSIU represent isolated potential breeding areas for amphibians and invertebrates. Potentially significant risks were noted for multiple stock tanks within the S/TSIU, mostly the furthest upstream tanks where sediment from most-affected sections of the S/TSIU are trapped. The sitewide BERA concluded that copper concentrations exceed water quality criteria and amphibian TRVs in these ponds and may limit production during times when water is present. Physical disturbance, in the form of cattle usage, is extensive in these areas and could also limit amphibian breeding.

The additional data collected during the S/TSIU RI, including data collected from Rustler, Martin and Lucky Bill canyons was used in this report to provide a more detailed evaluation of potential risks to aquatic receptors.

1.1.4 COPCs Evaluated in the S/TSIU ERA

The sitewide BERA identified a list of COPCs that were assessed for each of the three main assessment endpoints. The COPCs evaluated in the sitewide BERA are listed below and constitute the list of COPCs that are further evaluated using the additional data collected for S/TSIU ERA:

<u>Vegetation</u>

Copper

Hydrogen ion activity (pH)

<u>Terrestrial Wildlife</u>

Cadmium

Chromium

Copper

Lead

Molybdenum

Selenium

Zinc

<u>Aquatic Receptors</u>

Cadmium

Copper

Lead

Zinc

These chemicals were identified as COPCs in the sitewide BERA via the screening-level risk assessment process that conservatively compared upper-bound concentrations to risk-based toxicity values and were carried forward into the detailed risk analysis within that document.

1.1.5 Data Available for Use in the S/TSIU ERA

Data specific to the S/TSIU were collected as part of the S/TSIU RI (SRK 2005) and were presented and discussed in that report. Additional data were collected in July 2006 to help address several data gaps as part of the RI for the S/TSIU. These data are also included in this ERA. The RI data needs were identified based on data gaps identified for characterizing the nature and extent of contamination, as well as for the human health and ecological risk assessments. The primary ERA data needs were identified to: (1) fill spatial data gaps for soil in the S/TSIU, (2) obtain sediment samples along ephemeral drainages, and (3) obtain additional water samples from streams and tanks (i.e., stock ponds). The ERA risk analysis presented below includes all S/TSIU historical data evaluated in the BERA, and the data collected during the S/TSIU RI.

For the S/TSIU RI, surface soil (0 – 1" bgs), shallow soil (0 – 6"), surface water and sediment samples were collected to augment the existing data base (Figure 1.1-3). The shallow soil samples were specifically collected for ERA purposes while the surface soil samples were collected for use in the human health risk assessment. The surface soil samples were collected from the 0-1" interval and were sieved through a 200 um mesh to isolate only very fine soil particles. The shallow soil samples collected in support of the ERA were passed through a 2000 um sieve prior to sampling. Use of a 2000 um sieve was consistent with methodologies used in the sitewide BERA.

The surface soil data collected for the S/TSIU RI from the smaller size fraction are of use for the human health risk assessment but may be applicable for use in the ERA. The smaller size fraction sampled for the human health risk assessment soil samples represents the size fraction that would be most likely to adhere to human skin. While dermal exposure to wildlife receptors may be a pathway of exposure, it is generally considered to be of lower concern than ingestion pathways evaluated quantitatively in the sitewide BERA. Soil samples from the larger size fraction are more likely to represent the exposure that wildlife receptors may be exposed to when grazing, browsing, or burrowing.

Statistical comparisons between the two size-fraction datasets are presented in Appendix A (Figure A-1). Samples from the smaller size fraction contain significantly higher concentrations of metals probably due to the higher proportion of fines from smelter emissions and windblown tailing. The models used to estimate concentrations of metals in food tissues were developed based on the soil samples from the <2000 um size fraction collected for the sitewide BERA. Use of a smaller size fraction of soil may over-estimate the concentrations of metals in food items. Therefore, data from the smaller size fraction are not quantitatively used in the ERA.

The S/TSIU RI data used in the ERA analysis are presented in Appendix A (Tables A-3 through A-5). As noted above, data from the Eco RI (within the boundaries of the S/TSIU) are also included in this assessment as well as samples from the Background RI (BRI; CMC 1995) for the smelter and tailings IUs (as presented in the sitewide BERA). Additional sampling locations utilized in the ERA for the S/TSIU are presented in Appendix A and are shown on Figure 1.1-3. The Eco RI data are provided in Appendix F of the sitewide BERA (NewFields 2005). Data from S/TSIU RI samples S59 through S63 are not included in this analysis since they were collected within the Smelter Operational Area which is not included in the AOC.

1.2 Organization of the S/TSIU ERA Report

The S/TSIU ERA report is organized by groups of assessment endpoints. The ERA relies heavily on detailed problem formulation presentations provided in the sitewide BERA and TM-1 while focusing on the results of the S/TSIU RI sampling and the assessment of ecological risk in light of the greater resolution provided by the additional data. Risk analysis is grouped by assessment endpoint as follows:

Section 2: Risk Analysis for Vegetation in the S/TSIU;

Section 3: Risk Analysis for Wildlife in the S/TSIU;

Section 4: Risk Analysis for Amphibians and Aquatic Receptors in the S/TSIU; and

Section 5: Uncertainties

Section 6: Conclusions and Recommendations.

2.0 RISK ANALYSIS FOR VEGETATION IN THE S/TSIU

This section presents the S/TSIU risk analysis for the terrestrial vegetation assessment endpoint. As discussed in the sitewide BERA, the primary contaminant sources in the S/TSIU for upland areas are smelter emissions and windblown tailings (Figure 1.1-1). Prevailing winds in the area tend to be from the northwest (CMC 1995) and areas to the south and east of the Hurley smelter and tailings impoundments are, therefore, likely to be the most affected by dryfall from these aerial sources. This was evident, especially for copper and pH, in the BRI and ERI data (CMC 1995; Arcadis JSA 2001).

As described in the sitewide BERA and TM-1, the primary exposure pathway for terrestrial plants to COPCs in S/TSIU soils is through absorption or direct contact of roots with contaminated soils and the mobility and bioavailability of COPCs in soils are important considerations to the risk assessment. The geochemical behavior of metals and inorganics following deposition onto soils and sediments greatly affects their mobility, speciation, and bioavailability. Important geochemical reactions occur in soils that strongly affect the speciation of metals and the ease with which they are assimilated by plants. Most important is the pH of the immediate environment, and secondarily is the concentration of dissolved ligands. At acidic pHs, most metals occur in solution as the free metal ion (e.g., Cu2+ or Pb2+). As pH increases, the free metal ion bonds with dissolved ligands to form charged and uncharged dissolved complexes of varying stability and bioavailability (e.g., CuSO4o, CuHCO3+, CuCO3o, Cu-organic). Stable complexes exhibit substantially lower bioavailability, and hence lower toxicity, than weak complexes or the free metal ion. Depending on the pH, the proportion of metal complexes may comprise a significant portion of the total metal load in a system. Consequently, the total content of metals in soil and water is less important than the abundance of the speciation and bioavailable fraction present.

Other factors that affect speciation and mobility include the presence of iron, aluminum, and manganese oxyhydroxides, organic carbon content, and clay content. These phases act as strong sorbents that remove metals from solution and render them unavailable to biota. For example, copper forms strong complexes with organic carbon compounds and forms relatively insoluble carbonate or oxide compounds above a pH of 5.5. As such, copper may be largely bioavailable in acidic soils that are low in organic carbon, and unavailable in neutral pH, clayey soils rich in carbonate and organic matter.

In the presence of sufficient soil alkalinity (usually as calcium carbonate) typical of New Mexico soils, metals such as cadmium, lead, and zinc can be removed from solution as carbonate minerals, such as otavite (CdCO3), cerussite (PbCO3), or smithsonite (ZnCO3). Other inorganic constituents such as the metalloids arsenic, selenium, and molybdenum tend to form negatively charged oxyanions in soil solutions (e.g., AsO42-, SeO42- and MoO42-) that are relatively immobile when pHs are less than 7, but become mobile under slightly alkaline pH (pH>7). Most of the metal COPCs at the Chino Mine site are very susceptible to adsorption to aluminum, iron, and manganese oxy-hydroxide solids ("sesquioxides") in the soil zone. This is an extremely important removal mechanism because sesquioxides are abundant in New Mexico soils, and adsorption to these solids occurs even when COPC levels are below that required for metal precipitation.

Thus, metal bioavailability is dependent upon a complex combination of mineral content and pH of soils in affected areas. However, the overall most important factors for a given soil and contaminant type tend to be the total concentration and the pH. The vegetation risk analysis focused on these variables for assessing potential phytotoxicity and effects on vegetation.

2.1 Assessment Endpoint and Objective

The quality of vegetation in uplands and along ephemeral drainages as wildlife habitat is the primary assessment endpoint for the S/TSIU. Vegetation is critical as a food source and as physical habitat for wildlife. Loss of vegetative cover can also result in erosion of surface soils, which can inhibit revegetation. Various plant species have been shown to be sensitive to metals, including copper and acidic pH in soils by exhibiting toxic responses when exposed. Metal toxicity to vegetation can alter the plant community composition and structure, which can result in decreased wildlife habitat and range quality. The assessment objective was to determine the extent to which changes in metal concentrations and pH due to mine and mineral processing activities could adversely affect vegetation at the site.

2.2 Predicted pCu^{2+}

As noted in Section 1, bioavailable copper, especially pCu^{2+}, appears to be the best predictor of potential phytotoxicity. The predicted pCu^{2+} in each of the S/TSIU surface soil samples was calculated using the 2-variable (pH and total copper) model for the upland study and reference area locations presented in Table 1.1-3. This model was selected because it provided the highest degree of correlation with biological variables and was the best predictor of responses for the mostly upland areas of the S/TSIU. Results of those predicted pCu^{2+} values are presented in Table 2.2-1.

The DEL and PEL were derived in the sitewide BERA and represent site-specific estimates of potential toxic effects to the vegetation community. The DEL represents a range cupric ion activity level below which ecologically meaningful effects are not expected. The range of the DEL (pCu^{2+} > 7) is representative of the approximate level of cupric ion activity below which differences in measurements of endpoints related to species richness and variables related to canopy cover between the on-site and reference locations were not generally observed. The DEL incorporates a weight-of-evidence for both laboratory and field measurements and the potential for ecologically significant effects at pCu^{2+} values greater than 7 is expected to be low. Soils with pCu^{2+} values within the range of the upper and lower bound DEL values are similarly not expected to be affected by copper exposure related to site activities, but there is a lower confidence in that conclusion at pCu^{2+} values between 6 and 7.

Cupric ion activity is predicted to be less than 7 (the upper level of the DEL) in 22 of 38 total S/TSIU RI shallow soil samples (<2000 um). The predicted pCu^{2+} was within the range of the DEL (range of 6 to 7) in 6 samples.

Emergence, survival and rhizobial root nodule counts in laboratory test species were significantly reduced, as compared to reference areas, at pCu^{2+} values lower than 5. Similarly, species richness and canopy cover were also consistently lower at sampling locations with pCu^{2+} values less than 5. As a result, the BERA concluded that significant effects to components of the vegetation community could be expected in areas where the pCu^{2+} was less than the site-specific PEL. Eleven S/TSIU RI soil samples had pCu^{2+} values predicted to be less than the PEL. These areas represent the highest risk of adverse effects from copper and depressed pH, and some level of effects to community structure and/or plant growth is expected in these areas.

For soils with pCu^{2+} values between the DEL and the PEL, the prediction of ecologically significant effects to the vegetation community is more uncertain. The sitewide BERA indicated an increased potential for effects to plant growth and community structure at pCu^{2+} values less than 6, but the variability in the data did not indicate a clear threshold pCu^{2+} between the DEL and PEL. Some potential for changes in community structure and plant growth may be possible in soils with a pCu^{2+} between 5 and 6, but the probability of observing these effects is unknown but should be considered to be greater than in soils where the pCu^{2+} is higher than the DEL.

Data collected for the S/TSIU RI were consistent with previous data in that it shows (Figure 2.2-1), a general trend of lowest pCu^{2+} values nearest the smelter location, and increase with distance south east of the smelter location. This pattern is consistent with the pattern seen in the sitewide BERA. Figure 2.2-2 shows the pCu^{2+} values predicted for the S/TSIU samples and the samples evaluated in the sitewide BERA. There is considerable overlap in the predicted pCu^{2+} levels in the various datasets used to compile the figure.

2.3 Community Metric and Laboratory Phytotoxicity Testing

Results of the community assessment and laboratory phytotoxicity testing were presented in detail in the sitewide BERA. No additional data for either of these two measures were collected as part of the S/TSIU RI. The results of community and laboratory testing for the areas encompassed by the S/TSIU are summarized in this section.

Statistical analysis indicated that six of the eight locations closest to the smelter (ERA01 – ERA 08) and downwind had lower canopy cover and species richness when compared to reference areas. This trend was only noted in two other locations in the S/TSIU. The results from the remainder of the community metrics (e.g. litter cover, basal ground cover, etc.) were largely equivocal and the sitewide BERA concluded that effects to these metrics were uncertain.

Results of BERA phytotoxicity testing in the S/TSIU area indicated that soils most distant from the source areas were generally the least toxic samples tested while the areas closest to the smelter exhibited the most effects on emergence and growth of the test species (ryegrass and alfalfa). ERA01, the location closest to the smelter to the southeast consistently exhibited the largest effects in most measures. ERA01 had 0% survival and only slightly greater than 10% emergence while ERA05 had less than 30% survival and less than 45% emergence. ERA26, an overbank sample from Bolton Draw that had a moderate copper concentration, but very low pH also had no seedling emergence. Samples from locations within the S/TSIU study area with higher copper concentrations and high pH, or lower copper concentrations had results more similar to reference area samples had nearly 90% emergence and 80% survival.

Standard test species were used in soil phytotoxicity tests because the response of the species in such tests is well known, making interpretation of the tests results less uncertain, however, these 'naïve' species may not be physiologically adapted to soils in mineralized areas. A shift at the site to metals-tolerant species may or may not result in a loss of plant species that have a high capacity for supporting healthy wildlife populations. Adverse effects may occur if the species that increase in community dominance due to their tolerance of metals in soils are less valuable as wildlife resources (either as food sources or habitat) but the likelihood of those effects is unknown. Some level of difference in vegetation community composition is expected between areas with mineralized and non-mineralized soils, however, there is clear evidence in the areas predicted to have the highest probability of effects that copper concentrations in soils are elevated and pH is depressed due to smelter emissions or windblown tailings. The levels of pCu^{2+} that were found to be associated with vegetation effects in the BERA are beyond any reasonable estimates of background at the Site. Therefore, the effects-levels identified in the BERA likely represent altered conditions due to mine site activities, not natural background copper concentrations or naturally low pH that would be associated with an unaffected mineralized area. This was illustrated in the BERA using a hierachical cluster analysis (Ludwig and Reynolds 1988).

The hierarchical cluster analysis presented in the BERA is a measure of dissimilarity between the vegetation community data collected in the upland sites within the S/TSIU sampled for the background ERI. The product of this analysis is a dendrogram, or cluster diagram, that groups sites showing similar data. The dendrogram most applicable for the S/TSIU is presented in Figure 2.3-1 and was prepared using the present/absence and abundance of the 10 most common plant species identified in the Mesquite/Mixed Grama Shrubland vegetation alliance which occupies most of the S/TSIU (Figure 1.1-2). The figure indicates that ERA sampling sites closest to the smelter are the most similar in terms of species composition as compared to those further from the smelter. These results correspond closely with the results of other physical and community measures presented in Figures 2.3-2 through 2.3-4 that show a similar trend of changes with increasing distance from the smelter. These changes in vegetation community structure, cover and lab-based toxicity endpoints among the sites sampled in the S/TSIU are evident without consideration to background or reference area sites or grazing issues.

Cattle grazing has historically occurred throughout much of the S/TSIU and its effects represent another potential uncertainty in the vegetation risk analysis. Historical grazing has occurred both near the smelter and in areas further east. While the grazing history in the S/TSIU makes comparisons to a 'natural' plant community difficult, comparisons of vegetation community structure within the grazed areas of the S/TSIU provide valuable information related to potential effects on the community related to site contamination.

Similar data were not available for the S/TSIU soils sampled during the Phase 1 RI. While similar trends are expected, the lack of data in these areas represents a source of uncertainty. However, it is expected that the trends observed in the ERI data would be similar at the S/TSIU. Sampling locations lacking toxicity and community data, as related to the gradient of elevated copper concentrations and depressed pH and the DEL and PEL benchmarks for pCu^{2+}, represent a reasonable approach toward assessing the potential for community-level effects to vegetation in those areas.

The sitewide BERA concluded that phytotoxic conditions existed in the areas nearest to the smelter and in several locations east of the tailings impoundments. While community-level effects were less clear, there were statistically significant effects noted in two important parameters (total canopy cover and species richness) in the areas closest to the smelter. Given the significant correlations between the noted effects and pCu^{2+}, the potential for community-level phytotoxic effects that could have a negative effect on wildlife habitat may be significant in areas with elevated copper and depressed pH within the S/TSIU.

2.4 Terrestrial Vegetation Conclusions

Elevated concentrations of copper and other metals combined with depressed soil pH have led to increased risk of phytotoxicity for some areas of the S/TSIU. Adverse effects on community structure, density of cover and growth, seedling emergence and plant survival were noted in the sitewide BERA at sampling locations nearest the smelter and tailings impoundments. These effects were highly dependant on soil pH and copper concentration. Effects noted in the sitewide BERA were correlated with decreases in pCu^{2+}, and pCu^{2+} was highly predictable using measures of total soil copper and pH.

Data collected as part of the S/TSIU RI show a similar trend of higher predicted cupric ion activity (decreased pCu^{2+}) in areas nearest to the smelter and tailings impoundments. In general, cupric ion activity and subsequent risk to the vegetation community, and its function as wildlife habitat, decreases with distance from the smelter and tailings impoundments.

Field data on the vegetation community composition and quality were not collected for use in the S/TSIU RI, but predicted pCu^{2+} levels in several sampling locations are consistent with the range of those identified in the sitewide BERA samples as having the potential for exhibiting reduced plant growth, seedling emergence and/or survival.

The pCu^{2+} at ERA01, collected during the ERI, was approximately 3 and is lower than the pCu^{2+} calculated for any of the S/TSIU shallow soil samples. However, no additional shallow soil samples (0-6“) were collected in the vicinity of ERA01 in the S/TSIU RI. Surface samples (0-1”) S41, S42, S45 and S47 (Appendix A, Table A-3) were all collected a short distance southeast of the smelter. These samples were collected in support of the human health risk assessment and are representative of the smaller size fraction (<200 um). No pCu^{2+} values were calculated for these samples due to the different size fraction in the samples versus the soils used to derive the pCu^{2+} model in the sitewide BERA, however, all of the above referenced samples have depressed pH and elevated copper levels and may show similar effects on vegetation to those noted at ERA01.

A detailed discussion of the uncertainties in the terrestrial vegetation analysis is provided in the sitewide BERA. The discussion included in that document is directly applicable to this analysis. Overall, the largest source of uncertainty is whether wildlife habitat or overall ecosystem function is significantly affected by the observed effects. Laboratory studies and field studies showed that phytotoxicity and plant stress are evident in areas of highest metal concentration and lowest pH. These are relatively large areas on an absolute scale, and may represent an area of significantly degraded habitat that may be affecting the local population or sub-populations of the wildlife receptors that could utilize these areas. On a macro scale, the areas with elevated copper concentrations and depressed pH where phytotoxic effects are predicted represent a relatively small proportion of the overall mesquite-grassland habitat in the area available to wildlife receptors. The overall potential for effects to regional populations of wildlife is unknown.

Additional community and/or laboratory phytotoxicity data from the S/TSIU RI sample areas could decrease the level of uncertainty in the extrapolation of results from the ERA to the S/TSIU RI. In addition, confirmation data could also be collected to verify the predictive ability of the pCu^{2+} model.

3.0 RISK ANALYSIS FOR TERRESTRIAL WILDLIFE IN THE S/TSIU

This section provides additional risk analysis for terrestrial wildlife in order to supplement the analyses conducted as part of the sitewide BERA with the newly available data collected in the S/TSIU.

The sitewide BERA concluded that risk potentials were primarily elevated for the small ground-feeding bird receptor in the areas closest to the smelter and tailings impoundments. Risks to regional populations of wildlife were not predicted for any receptor and localized populations of large and mobile receptors (e.g., ruminants and mammalian/avian predators) were low. For these reasons, the risks assessed in this document will focus on the small ground-feeding bird receptor.

3.1 Exposure Point Concentrations

Statistics to represent exposure point concentrations (EPCs) were calculated using two software packages. The 95th percentile EPC, as used in the sitewide BERA, was calculated using Microsoft Excel™, while a 95th upper confidence limit (UCL) on the mean was calculated using ProUCL (EPA 2004). Summary statistics calculated using only data from the S/TSIU RI surface soils (0 – 6”, <2000 um) for the seven COPCs that were addressed under the detailed risk characterization portion of the sitewide BERA are presented in Table 3.1-1.

3.2 Comparison to Copper Soil Screening Levels

The sitewide BERA provided SSLs for copper in order to provide a quick screening tool to identify potential risks to the small ground-feeding bird and recommended that additional samples from the S/TSIU RI be compared to these values when the samples were available. No copper SSLs were provided for other receptors since the small ground-feeding bird was shown to be the most sensitive receptor to copper and SSLs calculated for this receptor would be protective of all other receptors.

A series of SSLs were calculated for the No Observed Adverse Effect Level (NOAEL) and Lowest Observed Adverse Effects Level (LOAEL) based TRVs based on HQs from 1 to 100, and soil bioavailability. The range of SSLs calculated in the sitewide BERA is provided in Table 3.2-1. Since copper may be tightly bound in the soil matrix in which it is found, the amount of copper that is passed through the digestive tract of the receptor and actually enters the bloodstream is likely to be lower than the total amount of copper ingested with the soil. The unabsorbed portion of the copper passes through the digestive system and is eliminated from the body. The absorbed portion of copper is represented by the relative bioavailability. The actual bioavailability of copper is almost certainly less than 100%, but is unknown for this site. Therefore, for calculation of SSLs, a range of soil bioavailability from 10 to 100% was used. Food bioavailability was assumed to be 100%. In Table 3.2.-1, soil bioavailability is represented as absorption factor (AF).

Copper bioavailability from food was assumed to be 100%. Copper that has been taken up into food tissues is expected to be considerably more bioavailable than soil copper. As such, without site-specific data indicating that copper in food items is not highly bioavailable, no adjustment to the copper AF from food should be made. This may over-estimate risk to an unknown degree, but the overestimation is not expected to be significant.

HQs exceeding 1 indicate that the predicted rate of exposure is greater than the rate of exposure represented by the TRV. If the TRV is a NOAEL, indicating a laboratory dose rate at which effects were not noted, then HQs greater than 1 indicate that risk cannot be dismissed as *de minimis,* but do not necessarily indicate unacceptable risk. HQs greater than 1 using a LOAEL TRV indicate that there is a potential for a risk based on the toxicological endpoint associated with the TRV. In general, the higher the HQ, the greater the likelihood of adverse effects.

The small ground-feeding bird was assumed to have a diet made up of 100% seeds. The median bioaccumulation factor (BAF) was used to estimate the seed concentration from the co-located soil concentration of copper (seed concentration = soil concentration X BAF). BAFs were calculated as the ratio of copper in food items versus co-located soil samples. The BERA indicated that no statistically significant correlation was present in the collocated soil and food item concentrations. As indicated in TM-2 (Schafer and Associates 1999b), the median BAF was used in this situation. The median BAF was calculated from soil and food item data collected as part of the ERI (Arcadis JSA 2001) and represents a source of uncertainty. Typically, accumulation of metals in food items occurs at a greater rate at lower soil concentrations than at higher concentrations. The use of the median BAF may, therefore, overestimate tissue concentrations at high concentrations and underestimate tissue concentrations at low soil copper concentrations. The copper SSLs were calculated using the median BAF for soil to seed concentrations from site data (BAF = 0.073).

The 95th percentile EPC for copper in the S/TSIU RI shallow soil samples is equal to 1,149 mg/kg (Table 3.2-2). When compared to the NOAEL and LOAEL SSLs, the HQs are 6.0 and 4.0, respectively, assuming 100% bioavailability from ingested soils. Using an assumption of 50% relative bioavailability from soils (but still assuming 100% bioavailability from food), the NOAEL and LOAEL HQs are 4.3 and 2.9, respectively. HQs calculated using the median soil (i.e., 50th percentile) concentration equaled 1.9 and 1.2 for the NOAEL and LOAEL TRVs, respectively, assuming 100% relative soil bioavailability.

The 95th UCL was not used as an EPC in the sitewide BERA due to the non-random nature of sampling (NewFields 2005). However, data were collected in a more systematic fashion for the S/TSIU RI which makes the 95th UCL an appropriate EPC for risk assessment purposes. The 95th UCL recommended by ProUCL (EPA 2004) equaled 543 mg/kg and resulted in NOAEL and LOAEL HQs equal to 2.8 and 1.9, respectively, when assuming 100% relative bioavailability from soils, and 2.0 and 1.4, respectively, when assuming 50% relative bioavailabilty from ingested soils. The results using the 95th UCL as the EPC are approximately equal to HQs calculated using the 75th percentile soil copper concentration. These results indicate moderate level potential risk to small ground-feeding birds in the S/TSIU.

Figure 3.2-1 shows the relative distribution of risk based on the HQs calculated for the small ground-feeding birds at S/TSIU RI sampling locations (shallow soil samples only). The HQs were calculated using a LOAEL TRV and assuming 50% bioavailability from soils. Figure 3.2-2 presents the results within the S/TSIU as presented in the sitewide BERA along with the HQs based on the S/TSIU RI data. As noted in the sitewide BERA, the highest HQs are located in the vicinity of the smelter and these samples heavily influence the overall prediction of risk for the S/TSIU as a whole.

The results of the S/TSIU ERA predict slightly higher risks than were predicted in the sitewide BERA, where the HQ calculated for the small ground-feeding bird using the sitewide 95th percentile soil and seed concentrations was 3.5 when assuming 100% bioavailability from soils although the 95^{th} percentile soil concentration for the upland soils was approximately twice the 95^{th} percentile of the S/TSIU samples. The use of the median BAF in the calculation of the SSL, therefore, appears to result in a slightly more conservative estimation of risk, in this situation, than the upper-bound tissue concentrations as used in the sitewide BERA.

3.3 Additional COPCs

No significant risks to any receptors from any COPCs other than copper were predicted in the sitewide BERA. For that reason, no additional SSLs were calculated in the sitewide BERA. Table 3.3-1 presents a comparison of the 95th percentile concentrations of each of the seven COPCs (upland soils only) discussed in the detailed risk analysis of the sitewide BERA to the S/TSIU RI-specific samples. Percentiles for the upland sampling locations from the ERI were compared to the 95th percentiles of the S/TSIU RI data.

For the S/TSIU shallow soil samples, the 95^{th} percentile concentrations of cadmium, lead, molybdenum, selenium and zinc were all lower than or equal to (selenium) the 95^{th} percentile concentrations evaluated as part of the sitewide BERA. This indicates that the risk characterization in the sitewide BERA is a conservative (i.e., more protective) representation of risks for the S/TSIU. No significant sitewide risks were predicted in the sitewide BERA for cadmium, lead, molybdenum, selenium and zinc in the upland areas of the S/TSIU. Therefore, data collected for the S/TSIU RI do not change this conclusion. Concentrations of cadmium, lead and zinc were locally elevated in areas near the Groundhog Mine and the Blackhawk Mine areas and in sample ERA 162 in Lucky Bill Canyon resulting in an area of elevated risk to several receptors, however, upper-bound soil concentrations within the bulk of the S/TSIU are much lower than those observed in the area of elevated concentration and risk from cadmium, lead and zinc appear to be isolated to those small areas that are outside of the S/TSIU.

The 95th percentile chromium concentration in S/TSIU shallow soils (19.4 mg/kg) was greater than the 95th percentile calculated in the sitewide BERA (16.8 mg/kg). The sitewide BERA indicated that HQs greater than 1.0 were calculated for the small ground-feeding bird using the NOAEL TRV (1.3 mg/kg BW/day; CEPA 1994). The sitewide BERA 95th percentile of soil and tissue concentrations resulted in a NOAEL HQ equal to 2.0.

Because the potential for risks exceeded screening-levels, chromium was carried forward into the detailed risk analysis. The sitewide BERA concluded that no significant risks were expected to the small ground-feeding bird receptor from chromium since 95th percentile soil and food concentrations resulted in a HQ equal to 0.2 using the LOAEL TRV (0.13 mg/kg BW/day; CEPA 1994). Additionally, it was noted that the maximum detected soil concentration evaluated in the sitewide BERA (22 mg/kg) was lower than the USEPA Ecological Soil Screening Guideline (EcoSSL) for birds (26 mg/kg; USEPA 2005).

The 95th percentile for chromium in S/TSIU shallow soils is similarly less than the EcoSSL value and although it is slightly higher than the sitewide BERA 95th percentile upon which the sitewide BERA conclusions were based, it is not elevated to a degree that would be expected to cause risk. Therefore, S/TSIU data do not affect previous conclusions from the BERA.

3.4 Histopathological Analysis

A histopathological analysis of small mammal kidney and liver tissues was presented in the sitewide BERA. A total of 52 small mammals were collected and sent to a laboratory for analysis of the presence/absence of hepatitis and nephritis. No additional data were collected as part of the S/TSIU RI.

The statistical analysis presented in the sitewide BERA provided no clear conclusions. While the incidence of both hepatitis (52% of animals) and nephritis (21% of animals) in animals collected both in the S/TSIU and H/WCIU was higher than noted in the animals collected from the reference area (22% and 0% of animals respectively), no statistically significant ($p < 0.05$) differences between the two datasets were noted. The sitewide BERA acknowledged several potential issues with the data, primarily based on the small reference area dataset ($n = 9$).

In summary, there were no meaningful statistical differences detected for histopathological lesions between the reference controls or onsite animals. The occurrence of lesions was examined by control versus onsite locations, by species, and along a metals gradient. However, for all evaluations, it appears that there is a trend in that the percentage of onsite animals affected with liver or kidney lesions is higher relative to the controls. As noted above, the specific causes of hepatitis and/or nephritis at the site are unknown, and results presented above are not intended to establish causes, only to evaluate trends with respect to exposure to study area conditions.

3.5 Terrestrial Wildlife Conclusions

Risks to the small ground-feeding bird receptor, the most sensitive receptor evaluated, appear to be elevated in the S/TSIU due to exposure from copper. The potential for risks is greatest in the areas immediately to the east of the smelter and the tailings impoundments, and decreases with increased distance east of those features. The low levels of risk predicted in the sitewide BERA for cadmium, lead, molybdenum, selenium and zinc are unchanged in the S/TSIU since data collected for the S/TSIU RI indicate that upper bound concentrations of those COPCs are equal to or lower in the S/TSIU than were predicted in the sitewide BERA. Upper-bound chromium concentrations in S/TSIU soils were greater than those evaluated in the sitewide BERA but the difference is small and no change in the sitewide BERA conclusions for the S/TSIU appears to be warranted. No significant risks are predicted in the S/TSIU for any of these COPCs. The results closely match the conclusions reached in the sitewide BERA.

Future risk management decisions made for the S/TSIU should take this potential for risks related to copper exposure to the small ground-feeding bird into consideration. The area where potential risks are predicted is large enough to support sub-populations of small resident birds. While a population of birds inhabiting the S/TSIU in the areas where risk is expected to be highest may have significant effects due to exposure to elevated levels of copper in soils and food items, there are no apparent areas of unique or high-quality habitat that would result in a preferential use of the area by the regional population of these birds. As such, the larger regional populations of small birds are not likely to be at elevated risk from exposure to copper in the S/TSIU.

Histopathological data from the liver and kidneys of small mammals collected within the S/TSIU and H/CIUs showed trends indicating that a higher percentage of animals within those areas exhibited some degree of hepatitis and/or nephritis than in those animals collected within the reference areas. These differences were not, however, statistically significant. The potential cause for the increased incidence of hepatitis and nephritis was not further evaluated in the sitewide BERA. These results indicate that although the HQ analysis indicates a low potential for risk to small mammalian populations inhabiting the S/TSIU, some level of effects due to contamination may exist. The significance of the histopathology for the assessment endpoint from these apparent trends shown in the histopathological analysis is, however, unknown.

4.0 RISK ANALYSIS FOR AQUATIC RECEPTORS IN THE S/TSIU

The sitewide BERA indicated that a potential for risks to aquatic receptors is present for aquatic biota in ephemeral pools along the Hanover and Whitewater corridors. The COPCs of most concern were cadmium, copper, lead and zinc. In addition, stock tanks and intermittent pools in the S/TSIU also were predicted to have some potentially significant risks to aquatic receptors since they represent isolated potential breeding areas for amphibians and aquatic invertebrates. Sediment data were identified in the sitewide BERA as a data need for these areas.

Physical disturbances from cattle were noted as a major factor that could also limit the ability of these isolated habitats to function as successful breeding grounds for amphibians. These stock tanks represent man-made habitats and any risks to regional populations predicted in these areas were considered to be highly uncertain.

As noted in Section 1, additional surface water and sediment data were collected as part of the S/TSIU RI. Sampling locations are presented on Figure 4.0-1.

4.1 Surface Water

The entire S/TSIU RI surface water dataset is provided in Appendix A, Table A-4. Table 4.1-1 presents surface water data for cadmium, chromium, copper, lead, molybdenum, selenium and zinc compared to amphibian TRVs (Harfenist et al. 1989 and Schafer and Associates 1999) and acute and chronic New Mexico Water Quality Criteria (NMWQC) (20.6.4 NMAC). Aquatic habitat in the S/TSIU varies from relatively permanent sections in Rustler Canyon to the distinctly ephemeral sections of Lampbright, Bolton Draw, and Whitewater Creek. Fish and amphibians have been observed in Rustler Canyon during the September 2007 sampling event between sampling locations SW09 and SW10 (P. Harrigan, pers. communication).

Both the chronic and acute NMWQCs apply to surface waters with a designated, existing or attainable use of “aquatic life” (i.e., permanent aquatic habitat). In cases where the designated use is defined as limited aquatic life, such as ephemeral conditions typical of the southwestern part of the state, only the acute NMWQCs are applicable. For risk assessment purposes, comparisons to both acute and chronic criteria are used as screening values.

Cadmium was detected in 5 of 25 total samples. Three of the detections from the 2006 round of sampling were qualified as blank contaminants (B-qualified). The amphibian no-effect TRV was not exceeded in any sample. The chronic NMWQC was exceeded in all detections with the acute criteria exceeded in sample CDW-1. Sample CDW-1 was collected in a ‘rocky grotto’ in the C drainage (just to the east of the Hurley smelter) (Figure 4.0-1). This sampling location also had the highest concentration of copper (0.327 mg/l). Habitats in these areas are highly disturbed due to CMC activities and provide poor quality aquatic habitat or breeding habitat for amphibians. However, flow from these areas to downgradient locations could affect habitat quality elsewhere.

Copper was detected in all surface water samples. Three samples collected during the 2006 sampling event were, however, B-qualified. Highly elevated concentrations from the three locations closest to the smelter (SW04, BD4W-1 and CDW-1) exceeded water quality criteria. Samples from one location adjacent to the tailings impoundments also had elevated copper concentrations but did not exceed NMAWQC because of high hardness values. High hardness at these locations is likely due to the influence of carbonates in tailings. The amphibian TRV was exceeded in 14 samples while the chronic NMAWQC was exceeded in 20 samples and the acute criterion was exceeded in 19 samples.

Copper concentrations in the samples more distant from the smelter than SW04, BD4W-1 and CDW-1 exceeded amphibian TRVs and both acute and chronic NMWQC but concentrations were generally an order of magnitude or more lower than the samples collected nearest the smelter.

The amphibian TRV is indicative of a no-effect level for successful metamorphosis in frogs (Porter and Hakanson 1976 as cited in Harfenist et al. 1989). Copper concentrations did not exceed the 0.5 mg/L concentration observed by Fort and Stover (1997; as cited in Pauli et al. 2000) above which abnormal hind limb development was observed.

Lead was detected in 7 of the samples collected during 2006, but all detections were B-qualified, indicating potential blank contamination. The chronic NMAWQC was exceeded in 4 of the 7 B-qualified detections, while the acute criterion and the no-effect amphibian TRV were never exceeded.

Zinc was detected in every pre-2006 surface water sample and in three post-2006 samples, but no exceedances of the no-effect amphibian TRV or either acute or chronic NMWQCs were noted.

Chromium, molybdenum and selenium results were included based on their inclusion as soil COPCs. None were detected in any sample at concentrations that exceeded their respective WQCs.

4.2 Sediment

The entire S/TSIU RI sediment dataset is provided in Appendix A, Table A-5. Table 4.2-1 presents sediment data for cadmium, chromium, copper, lead, molybdenum, selenium and zinc compared to the sediment TRVs used in the sitewide BERA. Sediment samples from test pits were excluded from this analysis. Cadmium, copper, lead and zinc were selected for further analysis in the S/TSIU based on results of the sitewide BERA that indicated they were the primary aquatic COPCs of concern at the Chino site. Chromium, molybdenum and selenium were included based on their presence as soil COPCs at the site.

Two types of sediment TRVs were evaluated. The threshold effect concentration (TEC) represents the concentration below which no significant toxicological effects are expected, similar to the NOAEL TRV used for the wildlife endpoints. The probable effects concentration (PEC) represents a concentration above which significant effects are predicted. The PEC is generally analogous to the LOAEL TRV used for the wildlife endpoint

Exceedances of the TEC were noted for cadmium (2 of 28 samples), copper (23 of 28 samples), lead (2 of 28 samples) and zinc (1 of 28 samples). The PEC was only exceeded by copper (9 of 28 samples). These results suggest that risk to aquatic life from exposure to cadmium, lead and zinc in sediments is likely to be low.

Risks from copper in sediments are elevated in many areas of the site, especially in the areas closest to the smelter and tailings impoundments. Concentrations of copper in A, B, C and D drainages are all significantly elevated over sediment criteria. Aquatic habitat quality in these highly ephemeral systems is low due to lack of flows. Of more importance to the aquatic community in the S/TSIU are those samples collected from more permanent aquatic habitat, such as the stock ponds, seeps and more perennial drainages within the Lampbright Draw drainage to the east of the Hurley smelter. Copper concentrations at location SED09, in mid-Rustler Canyon substantially exceeded the PEC value. Copper concentrations at other sampling locations within that drainage were less than the TEC (SED05), or between the TEC and PEC (SED06).

In stock ponds, copper concentration exceeds the PEC at SWS-6 and SED04, west of Hurley. All other sediment samples collected from stock ponds had sediment copper concentrations that were greater than the TEC but less than the PEC.

Molybdenum and selenium do not have available TEC or PEC benchmarks nor benchmarks values analogous to the TEC and/or PEC. Benchmarks were available for chromium and all detected concentrations were less than both benchmarks.

4.3 Aquatic Life Conclusions

The results of the S/TSIU aquatic risk analysis are consistent with those noted in the sitewide BERA. Where surface water exists in the S/TSIU, in most cases copper concentrations are elevated over acute and chronic water quality criteria. In ephemeral areas, acute criteria likely represent the most applicable criteria for comparison purposes. In areas of permanent water, such as stock ponds, that could support breeding sites for amphibians and aquatic invertebrates chronic criteria and amphibian TRVs likely provide useful comparison tools.

Potentially significant risks to aquatic life from copper in surface water are predicted for the limited aquatic habitat within the S/TSIU. The quality of the habitat and the highly ephemeral nature of the drainages with each seasonal precipitation event must be taken into consideration in any risk management decisions.

Risks to aquatic life from sediment exposure appear to be lower than those predicted for surface water. Only copper exceeded sediment TRVs that are potentially predictive of effects, but predominantly in areas that lack water for much of the year. More permanent water bodies that are potentially affected are the stock pond west of Hurley, and at location SED09 in Rustler Canyon. As with surface water, risk predictions for sediment should also be viewed in terms of quality of habitat and availability of water when making risk management decisions. Except in the areas closest to the smelter, copper concentrations in surface water do not appear to coincide with areas of elevated sediment copper concentrations.

Consideration of future conditions may also be important in assessing risk to aquatic receptors. For example, potential flow from Whitewater Creek has been diverted eastward into the Bolton Draw drainage via a large excavation. Currently, flow in both Whitewater Creek and Bolton Draw is ephemeral for most of the length in the S/TSIU. However, if conditions change such that flow is increased, residual salts in Bolton Draw sediments may be solubilized and made more available to aquatic life (or wildlife that drink from the pools). Such conditions could result if waste water from domestic water treatment or industrial use is discharged to Whitewater Creek above the diversion. Analysis of metal mobility from sediments is being evaluated as part of the Hanover Whitewater Creek IU, RI and ERA.

5.0 UNCERTAINTIES

Uncertainty is an inherent part of risk assessment. The sitewide BERA presented a comprehensive evaluation of the uncertainties specific to the sitewide BERA. The sources of uncertainty discussed in the sitewide BERA included:

- Sampling uncertainty and data gaps (i.e., uncertainty about spatial distribution of contamination as a consequence of limitations in sampling a site).

- Uncertainty in the selection of COPCs.

- Uncertainty in the natural (seasonal and/or annual) variability in the species, populations, communities, and ecosystems in question, as well as uncertainty regarding individual sensitivity to COPCs.

- Uncertainty in risk characterization using laboratory-based toxicity values and the HQ approach.

- Uncertainty in models and parameters used to estimate risk potentials.

- Uncertainty in assessing background COPC concentrations that may relate to calculated risk potentials.

A thorough discussion of these uncertainties is provided in the sitewide BERA and all apply to the risk assessment for the S/TSIU.

In general the sitewide BERA presented a conservative determination of COPCs and a less conservative risk characterization that provided ranges of potential risks for use in making risk management decisions. Sitewide COPCs were selected based on a conservative screening approach that minimized the potential for Type I error, or the potential for not selecting chemicals that are potential risk drivers as COPCs. This approach allows similar limitations of Type I error within the S/TSIU since the COPCs from the sitewide BERA were carried into this risk assessment.

Risk-based conclusions were reached in the sitewide BERA based on potential ranges of risk to the assessment endpoints. Similarly, this risk assessment used the conclusions reached in the sitewide BERA to assess potential risks within the S/TSIU. Conditions in the S/TSIU were reviewed in terms of the conditions that were discussed as potential risk drivers in the sitewide BERA. This approach assumes similar uncertainties in the S/TSIU assessment as those that were identified and discussed in the sitewide BERA.

There are additional uncertainties related to each assessment endpoint that require further discussion. For the vegetation community assessment endpoint, risk-based models using pCu^{2+} in soils to predict community-level effects is a significant source of uncertainty. Although the sitewide BERA showed strong correlations between pCu^{2+} in surface soils and community-level vegetation effects such as canopy cover and species richness, models designed to approximate reality are inherently uncertain. While it is unclear whether the pCu^{2+} over- or under-estimates the potential for community-level effects on the site vegetation, this source of uncertainty should be considered in risk management decisions for the site.

Similarly, for the small ground-feeding bird, risks were predicted in the areas closest to the Hurley smelter and the tailings impoundments where copper concentrations were highest. The assessment endpoint for wildlife receptors is based on effects to the populations of receptors. It is uncertain whether a viable population of small ground-feeding birds inhabits the areas associated with elevated copper concentrations. It is likely that a subpopulation of birds inhabits the area but it is unknown to what extent deleterious effects to the subpopulation that could be effected by copper concentrations would have on the sitewide population of birds.

Finally, for the aquatic receptors endpoint, very limited data regarding habitat quality and aquatic community presence and structure is known. While there are clearly concentrations of COPCs in surface water and sediment within the S/TSIU that could have deleterious effects to the aquatic community, the current presence or health of the community is not known. This uncertainty should also be considered by risk managers when determining a risk-based course of action for the S/TSIU.

6.0 CONCLUSIONS AND RECOMMENDATIONS

Risk of toxicity to plants and wildlife from soils is primarily due to elevated copper concentrations and depressed pH. Projected effects of elevated copper concentrations are exacerbated by the low alkalinity of soils in the area. Soil pH is measurably depressed in the downwind (east and southeast) areas of the site, where historic smelter emissions have deposited. Where pH levels are near neutral, phytotoxicity and potential for uptake of copper is substantially lower.

Potentially significant toxicity to the terrestrial plant community and terrestrial wildlife (small ground-feeding birds) is predicted in the vicinity (within 0.5 to 1 mile) of the smelter and tailings impoundments. In more outlying areas, pCu^{2+} in soils corresponds to levels that are likely toxic to laboratory test species used in this ERA. However, it is unclear whether there has been a significantly adverse effect on wildlife habitat quality (the Assessment Endpoint associated with vegetation). Even under pristine conditions, vegetation cover and quality in habitat like that found at S/TSIU is highly variable and it may be difficult to quantify differences in habitat quality based on field measures. At Chino, this is further confounded by the effects of (past) intensive grazing and other anthropogenic uses.

Therefore, it is likely that adverse impacts on individual habitat components could be measured, but community- or population-level effects from copper on wildlife species, from impacts to their habitat, may not be quantifiable. Increases in soil pH, increase in organic carbon content, or other changes in soils that reduce mobility and bioavailability of metals (especially copper), would help increase cover by herbaceous species, and improve habitat quality. Aquatic habitats would benefit from factors that decrease runoff of acidic, copper-containing soils into areas of streams or other areas that reliably collect water during otherwise dry periods.

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TABLES

Table 1.1-1
Summary of Assessment Endpoints as Defined in the Sitewide Baseline Ecological Risk Assessment

Management Goal:

Prevent or remediate adverse direct or indirect effects on ecological communities or populations of ecological receptors from toxic exposure to chemicals in mine waste

Assessment Endpoint	Risk Hypotheses or Question	Measures
	Exposure Assessment	
1. **Vegetation Community of Upland Sites**	1. COC concentrations in soils or vegetation do not exceed reference	Distribution of metals in soils and vegetation from site and reference areas
	2. COC concentrations in site soils do not exceed screening level TRVs	Metal concentrations in soils, TRVs for vegetation
	3. Nutrient levels are sufficient to support normal vegetation growth	K, P, NO_2+NO_3 TOC, pH in soils of site and background
	4. What proportion of landscape unit with [metals] in soils exceeding TRV or site-specific risk-based criterion	Distribution of elevated metal concentrations in soils or sediments
	Effects Assessment	
	5. Existing vegetation community at site is not degraded with respect to reference	Vegetation community structure in site and background areas; results of range quality assessment; sites located along gradient of conditions if possible
	6. Are COC concentrations or altered physical conditions in soils inhibiting recruitment?	Vegetation community and phytotoxicity test results for germination, root elongation, seedling growth from gradient of soil conditions
	7. Dose-response relationship exists between toxicity and soil contamination	" "
	8. What proportion of landscape unit(s) with adverse effects?	Spatial distribution of areas exhibiting adverse effects; elevated concentrations
	9. Are habitats in landscape unit fractionated by physical disturbance or chemical contamination?	Mapped distribution of vegetation types, wildlife species that may be restricted to habitat types against metal concentrations

Table 1.1-1
Summary of Assessment Endpoints as Defined in the Sitewide Baseline Ecological Risk Assessment

Management Goal:

Prevent or remediate adverse direct or indirect effects on ecological communities or populations of ecological receptors from toxic exposure to chemicals in mine waste

Assessment Endpoint	Risk Hypotheses or Question	Measures
	Exposure Assessment	
2 **Vegetation Community of Ephemeral Drainages**	1. COC concentrations in soils/sediments or vegetation exceed reference	Distribution of metals in soils and vegetation from site and reference areas
	2. COC concentrations in site soils exceed screening level TRVs	Metal concentrations in soils, TRVs for vegetation
	3. Dose-response relationship exists between residues and soil contamination	Metal concentrations in soils and plant tissues from co-located sites along gradient of conditions
	4. Nutrient levels are sufficient to support normal vegetation growth	K, P, NO_2+NO_3 TOC, pH in soils of site and background
	5. What proportion of landscape unit has [metals] in soils exceeding TRV or site-specific risk-based criterion?	Distribution of elevated metal concentrations in soils or sediments
	Effects Assessment	
	6. Existing vegetation community at site is not degraded with respect to reference area	Qualitative comparison of species present to unaffected or less affected sites (reference condition may not be available)
	7. COC concentrations are not accumulating in plant tissues	Metal concentrations in soils and plant tissues from gradient of conditions
	8. Are COC concentrations or altered physical conditions in soils inhibiting recruitment?	Phytotoxicity test results for germination, root elongation, seedling growth from gradient of soil conditions
	9. Dose-response relationship exists between toxicity and soil contamination	" "
	10. What proportion of landscape unit(s) with adverse effects?	Distribution of areas exhibiting adverse effects; elevated concentrations
	11. Habitats in landscape unit fractionated by physical disturbance or chemical contamination?	Mapped distribution of vegetation types, wildlife species that may be restricted to habitat types against metal concentrations

Table 1.1-1
Summary of Assessment Endpoints as Defined in the Sitewide Baseline Ecological Risk Assessment

Management Goal:

Prevent or remediate adverse direct or indirect effects on ecological communities or populations of ecological receptors from toxic exposure to chemicals in mine waste

Assessment Endpoint	Risk Hypotheses or Question	Measures
	<u>Exposure Assessment</u>	
3 **Herbivorous, Insectivorous, and Omnivorous Birds**	1. COC exposure do not exceed TRVs (estimate by habitat type [i.e., upland, ephemeral drainage] and location on site)	COC concentrations in soils, seeds, foliage, invertebrates; TRVs for small and large granivorous, omnivorous, and insectivorous birds; Intake calculations
	2. COC in exposure media do not exceed reference levels	COC concentrations in soils, seeds, foliage from site units and reference area
	3. What soil concentrations are associated with exposures that exceed TRVs?	Correlation between COC concentrations in soils and either (a) concentrations in forage or prey or (b) bioaccumulation factors
	<u>Effects Assessment</u>	
	4. Habitat quality is not degraded in potentially affected areas	Habitat quality (vegetation community structure) in site vs. reference
	5. What portion of landscape unit with [metals] in soils and vegetation exceed risk-based criterion?	Spatial distribution of elevated metal concentrations in sediments, soils, and vegetation in landscape unit(s)
	<u>Exposure Assessment</u>	
4 **Raptors**	1. COC exposure do not exceed TRVs (estimate by habitat type [i.e., upland, ephemeral drainage] and location on site)	COC concentrations in soils, invertebrates, small mammals TRVs for raptors; Intake calculations
	2. COC in exposure media do not exceed reference levels	COC concentrations in soils, prey
	3. What soil concentrations are associated with exposures that exceed TRVs?	Correlation between COC concentrations in soils and either (a) concentrations in forage or prey or (b) bioaccumulation factors
	<u>Effects Assessment</u>	
	4. Habitat quality is not degraded in potentially affected areas	Habitat quality (vegetation community structure) in site vs. reference
	5. What portion of landscape unit with [metals] in soils and vegetation exceed risk-based criterion?	Spatial distribution of elevated metal concentrations in sediments, soils, and vegetation in landscape unit(s)

Table 1.1-1
Summary of Assessment Endpoints as Defined in the Sitewide Baseline Ecological Risk Assessment

Management Goal:

Prevent or remediate adverse direct or indirect effects on ecological communities or populations of ecological receptors from toxic exposure to chemicals in mine waste

Assessment Endpoint	Risk Hypotheses or Question	Measures
	<u>Exposure Assessment</u>	
5 **Herbivorous, Granivorous, and Omnivorous Small Mammals**	1. COC exposure do not exceed TRVs (estimate by habitat type [i.e., upland, ephemeral drainage] and location on site)	COC concentrations in soils, seeds, foliage, invertebrates; TRVs for small and large granivorous, omnivorous, and insectivorous birds; Intake calculations
	2. COC in exposure media do not exceed reference levels	COC concentrations in soils, seeds, foliage from site units and reference area
	3. What soil concentrations are associated with exposures that exceed TRVs?	Correlation between COC concentrations in soils and either (a) concentrations in forage or prey or (b) bioaccumulation factors
	<u>Effects Assessment</u>	
	4 Histopathology is associated with elevated concentrations in tissues	COC concentrations in liver, kidney; Histopathological assessment of tissues
	5 Habitat quality is not degraded on site	Habitat quality (vegetation community structure) in site vs. reference
	6 What portion of landscape unit with [metals] in soils and vegetation exceed risk-based criterion?	Spatial distribution of elevated metal concentrations in sediments, soils, and vegetation in landscape unit(s)
	<u>Exposure Assessment</u>	
6 **Ruminant Wildlife**	1. COC exposure do not exceed TRVs (estimate by habitat type [i.e., upland, ephemeral drainage] and location on site)	COC concentrations in soils, foliage of palatable species; TRVs for ruminants; Intake calculations
	2. COC in exposure media do not exceed reference levels	COC concentrations in soils, seeds, foliage from site units and reference area
	3. What soil concentrations are associated with exposures that exceed TRVs?	Correlation between COC concentrations in soils and either (a) concentrations in forage (b) bioaccumulation factors for uptake soil-forage
	<u>Effects Assessment</u>	
	4. Habitat quality is not degraded on site	Habitat quality (vegetation community structure) in site vs. reference
	5. What portion of landscape unit with [metals] in soils and vegetation exceed risk-based criterion?	Spatial distribution of elevated metal concentrations in sediments, soils, and vegetation in landscape unit(s)

Table 1.1-1
Summary of Assessment Endpoints as Defined in the Sitewide Baseline Ecological Risk Assessment

Management Goal:

Prevent or remediate adverse direct or indirect effects on ecological communities or populations of ecological receptors from toxic exposure to chemicals in mine waste

Assessment Endpoint	Risk Hypotheses or Question	Measures
	Exposure Assessment	
7 **Mammalian Predators**	1. COC exposure do not exceed TRVs (estimate by habitat type [i.e., upland, ephemeral drainage] and location on site)	COC concentrations in soils, small mammals; TRVs for mammals; Intake calculations
	2. COC in exposure media do not exceed reference levels	COC concentrations in soils, seeds, foliage from site units and reference area
	3. What soil concentrations are associated with exposures that exceed TRVs?	Correlation between COC concentrations in soils and either (a) concentrations in forage (b) bioaccumulation factors for uptake soil-forage
	Effects Assessment	
	4. Habitat quality is not degraded on site	Habitat quality (vegetation community structure) in site vs. reference
	5. What portion of landscape unit with [metals] in soils and vegetation exceed risk-based criterion?	Spatial distribution of elevated metal concentrations in sediments, soils, and vegetation in landscape unit(s)
	Exposure Assessment	
8 **Amphibians**	1. Metal concentrations in water of breeding areas do not exceed toxicity thresholds for amphibians or aquatic life	Exposure Assessment Data on water quality from temporary and permanent aquatic habitat
	2. COC in exposure media do not exceed reference levels	Data on water quality from temporary and permanent aquatic habitat in reference area
	Effects Assessment	
	3. Determine whether amphibians occur in aquatic habitats to the extent expected	Presence/absence of breeding amphibians in aquatic habitats; site and reference (if available)
	4. Sediment are not toxic to aquatic stages of amphibians	Data on metal content of sediment in temporary and aquatic habitats; sediment toxicity testing if necessary

Table 1.1-2
R-Squared Values from Linear Regression Analyses for Laboratory Phytotoxicity and Community Endpoints (All Sites) Originally Presented in the Sitewide BERA (NewFields, 2005)

	Community and Phytotoxicity Endpoints								
	Community		Dry Weight		Length		Other Measures		
	Richness	Canopy Cover	Stem	Root	Stem	Root	Nodules	Emergence	Survival
Chemical Variables									
pCu^{2+}	0.614	0.462	0.733	0.694	0.665	0.486	0.432	0.231	0.267
Soluble Cu (SPLP)	0.455	0.242	0.338	0.546	0.298	0.548	0.194	0.399	0.408
CaCl2 Sol Cu	0.507	0.067	0.337	0.373	0.178	0.313	0.480	0.084	0.118
Total Cu (In trans)	0.472	0.240	0.305	0.411	0.176	0.369	0.407	0.106	0.104
pH, paste	0.461	0.100	0.215	0.202	0.339	0.151	0.364	0.053	0.090
Soluble Zn (SPLP)	0.231	0.058	0.095	0.150	0.064	0.179	0.118	0.221	0.209
Total Zn	0.000	0.032	0.036	0.036	0.117	0.042	0.104	0.054	0.075
Soluble Cd (SPLP)	0.002	0.077	0.021	0.024	0.007	0.002	0.032	0.003	0.001
Total Cd	0.037	0.002	0.002	0.001	0.011	0.001	0.152	0.001	0.000
Soluble Al (SPLP)	0.170	0.107	0.198	0.159	0.246	0.218	0.023	0.296	0.267
Total Al	0.116	0.033	0.195	0.112	0.221	0.089	0.010	0.031	0.034
Total Se	0.267	0.118	0.086	0.138	0.033	0.132	0.248	0.046	0.041
Physical Variables									
Soil DOC	0.071	0.367	0.307	0.108	0.257	0.021	0.056	0.033	0.038
Soil Organic Matter	0.029	0.005	0.006	0.003	0.003	0.027	0.141	0.086	0.072
% Silt	0.019	0.024	0.003	0.039	0.009	0.100	0.007	0.187	0.166
% Clay	0.117	0.049	0.078	0.105	0.080	0.035	0.033	0.006	0.003
% Sand	0.080	0.060	0.030	0.111	0.047	0.146	0.000	0.196	0.167

Shaded cells indicate highest R squared
Soluble copper data from Site 26 were eliminated for all endpoints

Table 1.1-3

Predictablity of pCu^{2+} in Chino ERA Soil Samples
Originally Presented in the Sitewide BERA (NewFields 2005)

Stepwise multiple regression was used to identify variables that were most important in predicting pCu2+. Soil pH and total copper concentration (ln-transformed) typically accounted for more than 90 percent of the varibility. Dissolved organic carbon was typically the third most important but contributed relatively little to predictive power.

Combination of Locations		Equation	R-squared
All Locations	2-var.	$3.28+(1.12*pH)-(0.64*\ln[Cu_{tot}])$	0.90
	3-var.	$2.77+(1.12*pH)-(0.62*\ln[Cu_{tot}])+(0.17*[DOC])$	0.92
Upland Study Only	2-var.	$6.16+(1*pH)-(1.02*\ln[Cu_{tot}])$	0.96
	3-var.	$4.63+(1*pH)-(0.84*\ln[Cu_{tot}])+(0.19*[DOC])$	0.96
Upland Study & Reference	2-var.	$7.34+(0.93*pH)-(1.15*\ln[Cu_{tot}])$	0.97
	3-var.	$6.47+(0.92*pH)-(1.04*\ln[Cu_{tot}])+(0.13*[DOC])$	0.97
Ephemeral Drainage	2-var.	$-0.56+(1.32*pH)-(0.18*\ln[Cu_{tot}])$	0.93
	3-var.	$1.15+(1.12*pH)-(0.18*\ln[Cu_{tot}])+(1.76*[DOC])$	0.96

Table 2.2-1
Predicted Cupric Ion Activity (pCu2+) in S/TSIU RI Soil Samples
Chino Mine Smelter-Tailing IU Ecological Risk Assessment

ST IU Sample ID	Total Copper Concentration (mg/kg)	pH	pCu2+
S72	1160	7.85	6.5
S73	1290	7.72	6.3
S74	529	7.71	7.3
S75	940	7.75	6.7
S76	278	7.78	8.1
S77	267	7.86	8.2
S78	207	7.79	8.5
S79	157	7.95	8.9
S80	1440	6.69	5.2
S81	875	6.8	5.9
S82	455	3.93	4.0
S83	358	3.96	4.3
S84	362	7.3	7.4
S85	451	3.88	3.9
S86	513	3.79	3.7
S87	309	4.33	4.8
S88	484	7.7	7.4
S89	399	4.48	4.6
S90	255	7.86	8.3
S91	926	7.05	6.0
S92	581	3.78	3.5
S93	308	4.22	4.7
S94	313	4.28	4.7
S95	494	5.96	5.7
S96	237	7.61	8.1
ERA159D	809	7.59	6.7
ERA160D	34.1	7.6	10.3
ERA161D	556	7.85	7.4
ERA162	218	6.44	7.1
ERA163	208	6.95	7.7
ERA164	136	5.62	6.9
ERA165	177	6.9	7.8
SS118D	259	4.99	5.6
SS119D	125	6.1	7.5
SS124D	523	7.56	7.2
SS125D	166	5.22	6.3
SS129D	337	4.07	4.4
SS131D	444	4.76	4.8

pCu2+ near the DEL
pCu2+ < DEL and > PEL
pCu2+ < PEL

$pCu2+ = 7.34 + (0.93*pH)-(1.15*\ln[Cu_{tot}])$ $r^2 = 0.97$ (NewFields 2005)

Table 3.1-1
Exposure Point Concentrations for Wildlife Receptors
In the S/TSIU

COPC	95th Percentile	75th Percentile	Median	95th Upper Confidence Limit	95th Percentile Upland Soils (NewFields 2005)
Cadmium	1.38	0.57	0.33	0.6	3.22
Chromium	18.8	10	8.05	10.5	16.8
Copper	1149	521	360	543	2310
Lead	30.4	19.4	15.7	49.5	40.9
Molybdenum	27.8	9.7	5.6	14	43
Selenium	1.97	0.8	0.4	1.4	2
Zinc	80.5	48.3	33	161	91.5

All units are presented in mg/kg DW

Table 3.2-1
Calculated Soil Screening Levels For Copper
Originally Presented in the Sitewide BERA (NewFields 2005)

Receptor	Analye	TRV	AF_s	SSLs (mg/kg) Based on Target Hazard Quotient						
				1	2	5	10	25	50	100
Dark-Eyed Junco	Copper, total	28 (NOAEL)	0.1	390	781	1,952	3,904	9,761	19,522	39,044
			0.25	333	667	1,666	3,333	8,331	16,663	33,325
			0.5	268	536	1,339	2,679	6,697	13,393	26,786
			1	192	385	962	1,924	4,809	9,619	19,237
		42 (LOAEL)	0.1	586	1,171	2,928	5,857	14,641	29,283	58,566
			0.25	500	1000	2,499	4,999	12,497	24,994	49,988
			0.5	402	804	2,009	4,018	10,045	20,090	40,180
			1	289	577	1,443	2,886	7,214	14,428	28,856

Note: The small ground-feeding bird (Dark-Eyed Junco) was shown to be the most sensitive receptor to copper; therefore, SSLs derived for this receptor would also be protective of all other receptors evaluated in the Wildlife Risk Analysis.

Afs = Bioavailability factor for soil ingestion.

Table 3.2-2
Hazard Quotients For Copper; Small Ground-Feeding Bird Receptor
Smelter Talings IU Ecological Risk Assessment

Receptor	Analye	TRV	AF_s	SSL (mg/kg)	95th Percentile 1,149	75th Percentile 521	Median 360	95th UCL 543
Dark-Eyed Junco	Copper, total	28 (NOAEL)	0.1	390	2.9	1.3	0.9	1.4
			0.25	333	3.4	1.6	1.1	1.6
			0.5	268	4.3	1.9	1.3	2.0
			1	192	6.0	2.7	1.9	2.8
		42 (LOAEL)	0.1	586	2.0	0.9	0.6	0.9
			0.25	500	2.3	1.0	0.7	1.1
			0.5	402	2.9	1.3	0.9	1.4
			1	289	4.0	1.8	1.2	1.9

Note: The small ground-feeding bird (Dark-Eyed Junco) was shown to be the most sensitive receptor to copper; therefore, SSLs derived for this receptor would also be protective of all other receptors evaluated in the Wildlife Risk Analysis.

Table 3.3-1
Comparison of S/TSIU and Sitewide BERA
Upper-Bound Exposure Point Concentrations

COPC	S/TSIU 95th Percentile	95th Percentile Upland Soils (NewFields 2005)
Cadmium	1.38	3.22
Chromium	***18.8***	16.8
Copper	1149	2310
Lead	30.4	40.9
Molybdenum	27.8	43
Selenium	1.97	2
Zinc	80.5	91.5

All units are presented in mg/kg DW
COPC has a higher 95th Percentile in S/TSIU data than observed in ERI Data

Table 4.1-1
Comparison of Surface Water Data to Amphibian TRVs and NMWQC

Parameter Hardness (Calculated)	BD4W-1 11/20/2004 68.5	CDW-1 11/20/2004 52.4	SW-1 11/19/2004 80.2	SW-2 11/19/2004 72.3	SW-3 11/19/2004 26.5	SW-4 11/19/2004 74.5	SW-204[1] 11/19/2004 71.4	SW-5 11/20/2004 62.7	SW-6 11/21/2004 95.4	SW-01 7/11/2006 69.6	SW-02 7/11/2006 253.1	SW-03 7/11/2006 222.4
Cadmium, dissolved	0.0012	0.0015	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Amphibian [2]	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004
Acute Criteria [3]	0.0014	**0.0011**	0.0016	0.0015	0.0006	0.0015	0.0015	0.0013	0.0019	0.0014	0.0050	0.0044
Chronic Criteria [3]	**0.0002**	**0.0002**	0.0002	0.0002	0.0001	0.0002	0.0002	0.0002	0.0002	0.0002	0.0005	0.0004
Chromium, dissolved	ND	ND	ND	0.00038	ND	ND	ND	ND	ND	ND	ND	ND
Amphibian [2]	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003
Acute Criteria [3]	0.418	0.336	0.476	0.437	0.192	0.448	0.432	0.389	0.548	0.423	1.219	1.096
Chronic Criteria [3]	0.054	0.044	0.062	0.057	0.025	0.058	0.056	0.051	0.071	0.055	0.159	0.143
Copper, dissolved	0.207	0.327	0.0436	0.0514	0.038	0.0371	0.0338	0.0606	0.0954	0.0153	0.005 B	0.0209
Amphibian [2]	**0.02**	**0.02**	**0.02**	**0.02**	**0.02**	**0.02**	**0.02**	**0.02**	**0.02**	0.02	0.02	**0.02**
Acute Criteria [3]	**0.009**	**0.007**	**0.011**	**0.010**	**0.004**	**0.010**	**0.010**	**0.009**	**0.013**	**0.010**	0.032	0.029
Chronic Criteria [3]	**0.006**	**0.005**	**0.007**	**0.007**	**0.003**	**0.007**	**0.007**	**0.006**	**0.009**	**0.007**	0.020	**0.018**
Lead, dissolved	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.0028 B	ND
Amphibian [2]	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005
Acute Criteria [3]	0.043	0.032	0.051	0.045	0.015	0.047	0.045	0.039	0.061	0.043	0.175	0.152
Chronic Criteria [3]	0.002	0.001	0.002	0.002	0.001	0.002	0.002	0.002	0.002	0.002	0.007	0.006
Molybdenum, dissolved	0.0082	0.0035	0.0143	0.0109	0.0035	0.0048	0.006	0.008	0.0124	0.0021 B	0.0036 B	0.0053 B
Amphibian [2]	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Acute Criteria [3]	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Chronic Criteria [3]	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Selenium, total	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.00051 B	0.0013 B	ND
Amphibian [2]	0.009	0.009	0.009	0.009	0.009	0.009	0.009	0.009	0.009	0.009	0.009	0.009
Acute Criteria [3]	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.020
Chronic Criteria [3]	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005
Zinc, dissolved	0.0232	0.0403	0.002	0.0029	0.0018	0.0017	0.0012	0.0023	0.00073	ND	0.0015 B	0.0307
Amphibian [2]	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
Acute Criteria [3]	0.085	0.068	0.097	0.089	0.038	0.091	0.088	0.079	0.113	0.086	0.257	0.231
Chronic Criteria [3]	0.086	0.068	0.098	0.090	0.038	0.092	0.089	0.080	0.114	0.087	0.259	0.233

Table 4.1-1
Comparison of Surface Water Data to Amphibian TRVs and NMWQC

Parameter Hardness (Calculated)	SW-04 7/11/2006 58.8	SW-05 7/12/2006 347.6	SW-06 7/12/2006 40	SW-07 7/13/2006 90.1	SW-08 7/13/2006 150.9	SW-09 7/14/2006 125.7	SW-10 7/14/2006 88.6	SW-11 7/17/2006 49	SW-12 7/17/2006 52.2	SW-13 7/17/2006 82.9	SW-14 7/18/2006 27.1	SW-15 7/18/2006 46.4
Cadmium, dissolved	ND	0.0014 B	ND	ND	ND	ND	ND	ND	ND	ND	0.00039 B	0.00031 B
Amphibian (2)	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004
Acute Criteria (3)	0.0012	0.0068	0.0008	0.0018	0.0030	0.0025	0.0018	0.0010	0.0011	0.0017	0.0006	0.0010
Chronic Criteria (3)	0.0002	**0.0006**	0.0001	0.0002	0.0003	0.0003	0.0002	0.0001	0.0002	0.0002	**0.0001**	**0.0001**
Chromium, dissolved	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.00039 B	0.00031B
Amphibian (2)	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003
Acute Criteria (3)	0.369	1.581	0.269	0.523	0.798	0.687	0.516	0.318	0.335	0.489	0.196	0.304
Chronic Criteria (3)	0.048	0.206	0.035	0.068	0.104	0.089	0.067	0.041	0.044	0.064	0.025	0.040
Copper, dissolved	0.22	0.055	0.0197	0.0151	0.005 B	0.0091 B	0.0041 B	0.0487	0.0514	0.0495	0.0518	0.0721
Amphibian (2)	**0.02**	**0.02**	0.02	0.02	0.02	0.02	0.02	**0.02**	**0.02**	0.02	0.02	0.02
Acute Criteria (3)	**0.008**	**0.043**	**0.006**	**0.012**	0.020	0.017	0.012	**0.007**	**0.007**	**0.011**	**0.004**	**0.007**
Chronic Criteria (3)	**0.006**	**0.026**	**0.004**	**0.008**	0.013	0.011	0.008	**0.005**	**0.005**	**0.008**	**0.003**	**0.005**
Lead, dissolved	0.002 B	0.003 B	0.0017 B	ND	ND	ND	ND	ND	ND	ND	0.0037 B	0.002 B
Amphibian (2)	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005
Acute Criteria (3)	0.036	0.243	0.024	0.058	0.101	0.083	0.057	0.029	0.032	0.053	0.015	0.028
Chronic Criteria (3)	**0.001**	0.009	**0.001**	0.002	0.004	0.003	0.002	0.001	0.001	0.002	**0.001**	**0.001**
Molybdenum, dissolved	0.0053 B	0.004 B	ND	0.0036 B	ND	ND	ND	0.0055 B	0.0068 B	0.0042 B	0.0091	0.0168
Amphibian (2)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Acute Criteria (3)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Chronic Criteria (3)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Selenium, total	0.0011 B	0.00076 B	ND	0.00057 B	0.00072 B	ND	ND	0.00089 B	0.0012 B	0.00021 B	0.00059 B	0.00092 B
Amphibian (2)	0.009	0.009	0.009	0.009	0.009	0.009	0.009	0.009	0.009	0.009	0.009	0.009
Acute Criteria (3)	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.020
Chronic Criteria (3)	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005
Zinc, dissolved	ND	0.11	ND	ND	ND	ND	ND	ND	ND	ND	0.0024 B	ND
Amphibian (2)	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
Acute Criteria (3)	0.075	0.337	0.054	0.107	0.166	0.142	0.106	0.064	0.068	0.100	0.039	0.061
Chronic Criteria (3)	0.075	0.340	0.054	0.108	0.167	0.143	0.107	0.065	0.068	0.101	0.039	0.062

Notes:

(1) duplicate sample of SW-4

(2) No-Effect Concentration based on data presented in Harfenist et al. 1989 or derived in TM-1 (Schafer and Associates 1999)

(3) Calculated with equation 1b or 2a of 20.6.4.900(I) NMAC; As Amended thorugh July 17, 2005.

Bold - Detected concentration is greater than the TRV

ND = Not Detected

Analytical results are presented in mg/L.

Hardness calculations presented on Table B-1 (Appendix B of this document)

The hardness value for sample SW-16 was greater than 400 mg/l, per NMED regulations, 400 mg/L hardness was used to calculate criteria for that sample

Table 4.2-1
Comparison of Sediment Concentrations to TRVs

Parameter	A DRAINAGE#2 11/21/2004	B DRAINAGE#2 11/21/2004	C DRAINAGE#2 11/21/2004	D DRAINAGE#2 11/21/2004	BD1 11/20/2004	BD2 11/20/2004	BD3 11/20/2004	BD4 11/20/2004	CDSWS-1 11/21/2004
Cadmium	2.6	0.65	0.33	3.5	0.2	0.38	0.13	0.44	0.09
Threshold Effects Concentration	**0.99**	0.99	0.99	**0.99**	0.99	0.99	0.99	0.99	0.99
Probable Effects Concentration	4.98	4.98	4.98	4.98	4.98	4.98	4.98	4.98	4.98
Copper	2,100	502	556	3,050	102	274	47	221	109
Threshold Effects Concentration	**32**	**32**	**32**	**32**	**32**	**32**	**32**	**32**	**32**
Probable Effects Concentration	**149**	**149**	**149**	**149**	149	**149**	149	**149**	149
Chromium	14	37.1	5.9	13	3.8	7.3	2.6	3.7	3.1
Threshold Effects Concentration	43	43	43	43	43	43	43	43	43
Probable Effects Concentration	110	110	110	110	110	110	110	110	110
Lead	44.5	25.5	18.2	81	8.4	9.2	7.5	13.3	15.7
Threshold Effects Concentration	**35.8**	35.8	35.8	**35.8**	35.8	35.8	35.8	35.8	35.8
Probable Effects Concentration	128	128	128	128	128	128	128	128	128
Molybdenum	8.7	3.4	6.3	11.6	1.5	3.5	1.2	3.1	3.1
Threshold Effects Concentration	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Probable Effects Concentration	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Selenium	ND	ND	ND	ND	ND	ND	ND	ND	ND
Threshold Effects Concentration	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Probable Effects Concentration	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Zinc	91.5	62.2	29.7	168	11.7	23.9	8.9	16.1	11.4
Threshold Effects Concentration	121	121	121	**121**	121	121	121	121	121
Probable Effects Concentration	459	459	459	459	459	459	459	459	459

[1] Duplicate sample. Duplicate sample follows the primary sample

Sample results are presented in mg/kg

Bold = TRV is exceeded by the sample concentration

TEC and PEC; MacDonald et al. 2000

N/A - No comparable benchmark available.

Test pit sediment samples are not included in the analysis.

Table 4.2-1
Comparison of Sediment Concentrations to TRVs

Parameter	LDS-1 11/20/2004	SWS-1 11/19/2004	SWS-2 11/19/2004	SWS-3 11/19/2004	SWS-4 11/19/2004	SWS-204(1) 11/19/2004	SWS-5 11/20/2004	SWS-6 11/21/2004	SED01 7/11/2006	SED02 7/11/2006
Cadmium	0.12	0.13	0.08	0.05	0.25	B 0.25	0.16	0.58	0.16	0.07
Threshold Effects Concentration	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99
Probable Effects Concentration	4.98	4.98	4.98	4.98	4.98	4.98	4.98	4.98	4.98	4.98
Copper	22	48	45	43	88	96	137	423	78	21.8
Threshold Effects Concentration	32	**32**	**32**	**32**	**32**	**32**	**32**	**32**	**32**	32
Probable Effects Concentration	149	149	149	149	149	149	149	**149**	149	149
Chromium	7.5	6.9	6.8	2.5	16.4	17.7	3.6	7.4	7.1	3
Threshold Effects Concentration	43	43	43	43	43	43	43	43	43	43
Probable Effects Concentration	110	110	110	110	110	110	110	110	110	110
Lead	9.2	11.3	10.4	4.9	18.6	B 20.1	7.6	20.4	10.2	7.4
Threshold Effects Concentration	35.8	35.8	35.8	35.8	35.8	35.8	35.8	35.8	35.8	35.8
Probable Effects Concentration	128	128	128	128	128	128	128	128	128	128
Molybdenum	1	0.83 B	0.95 B	0.88 B	1.6	1.8	1.8	3.4	1.4	0.48 B
Threshold Effects Concentration	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Probable Effects Concentration	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Selenium	ND	ND	ND	ND	2.3	ND	ND	ND	0.2 B	0.11 B
Threshold Effects Concentration	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Probable Effects Concentration	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Zinc	30.3	16.1	13.1	10	52	55.5	11.3	43.4	22.1	35.9
Threshold Effects Concentration	121	121	121	121	121	121	121	121	121	121
Probable Effects Concentration	459	459	459	459	459	459	459	459	459	459

(1) Duplicate sample. Duplicate sample follows the primary sample

Sample results are presented in mg/kg

Bold = TRV is exceeded by the sample concentration

TEC and PEC; MacDonald et al. 2000

N/A - No comparable benchmark available.

Test pit sediment samples are not included in the analysis.

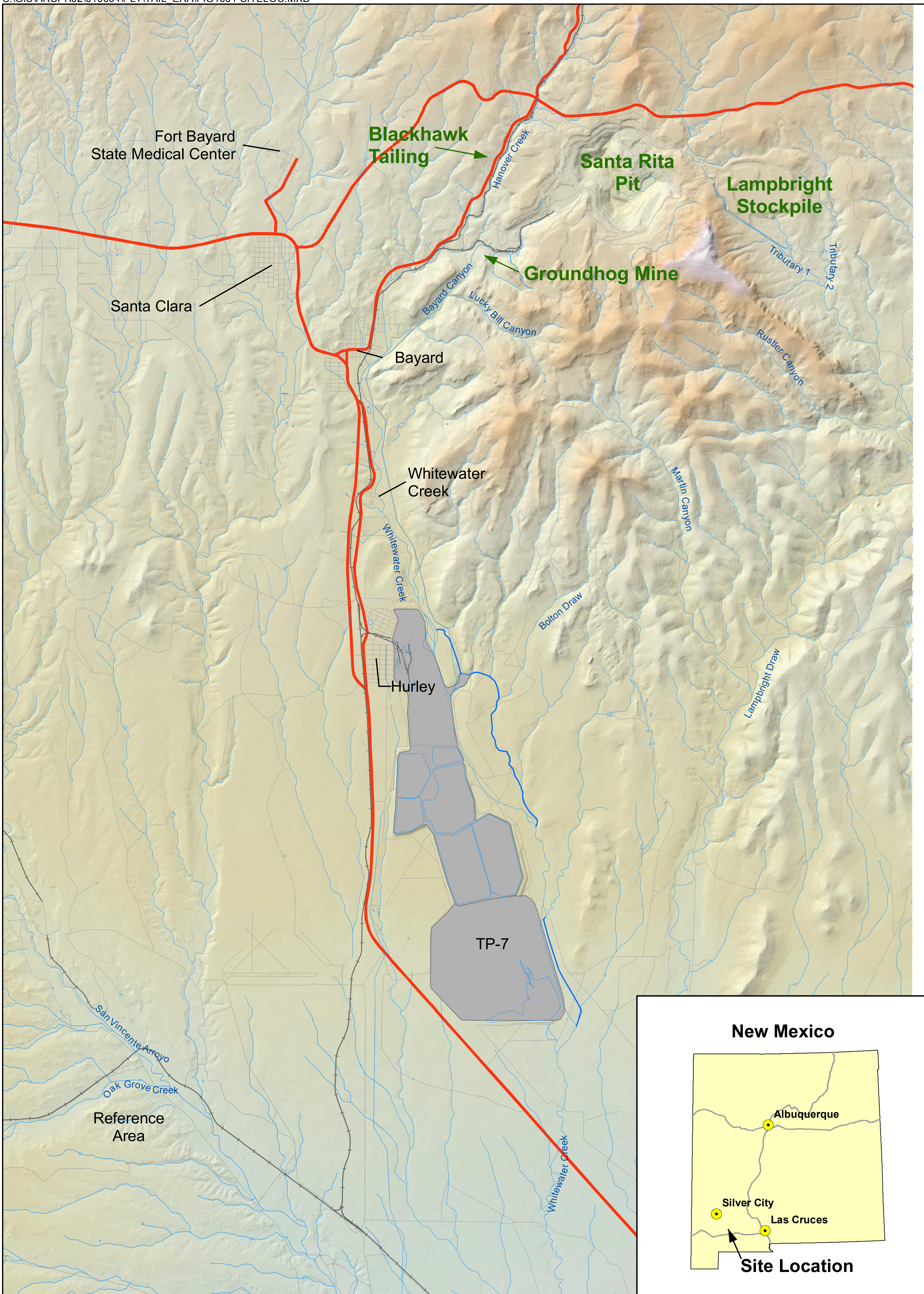
Table 4.2-1
Comparison of Sediment Concentrations to TRVs

Parameter	SED03 7/11/2006	SED04 7/11/2006	SED05 7/12/2006	SED06 7/12/2006	SED07 7/13/2006	SED08 7/13/2006	SED09 7/14/2006	SED10 7/14/2006	SED11 7/20/2006
Cadmium	0.27	0.53	0.11	0.08	0.06	0.03	0.61	0.03	0.28
Threshold Effects Concentration	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99
Probable Effects Concentration	4.98	4.98	4.98	4.98	4.98	4.98	4.98	4.98	4.98
Copper	45.6	280	62.6	26.4	49.1	12.2	565	22.6	87.5
Threshold Effects Concentration	**32**	**32**	**32**	32	**32**	32	**32**	32	**32**
Probable Effects Concentration	149	**149**	149	149	149	149	**149**	149	149
Chromium	4.5	12.1	6.7	2.1	12.1	4.6	21.7	5.9	16
Threshold Effects Concentration	43	43	43	43	43	43	43	43	43
Probable Effects Concentration	110	110	110	110	110	110	110	110	110
Lead	20.8	20.8	10.5	7.3	7.2	3.4	23.1	7.5	10.9
Threshold Effects Concentration	35.8	35.8	35.8	35.8	35.8	35.8	35.8	35.8	35.8
Probable Effects Concentration	128	128	128	128	128	128	128	128	128
Molybdenum	1.1	3	1.2	0.71 B	0.7 B	0.43 B	4	0.78 B	1.4
Threshold Effects Concentration	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Probable Effects Concentration	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Selenium	0.28 B	0.34 B	0.21 B	0.15 B	0.05 B	0.2 B	ND	0.06 B	0.28
Threshold Effects Concentration	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Probable Effects Concentration	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Zinc	82.3	51.7	23	19.2	22.6	13.5	63.4	18.9	65.4
Threshold Effects Concentration	121	121	121	121	121	121	121	121	121
Probable Effects Concentration	459	459	459	459	459	459	459	459	459

(1) Duplicate sample. Duplicate sample follows the primary sample
Sample results are presented in mg/kg
Bold = TRV is exceeded by the sample concentration
TEC and PEC; MacDonald et al. 2000
N/A - No comparable benchmark available.
Test pit sediment samples are not included in the analysis.

FIGURES

S:\GIS\ARCPRJ2\010054\PLT\TAIL_ERA\FIG1001-SITELOC.MXD



Legend

- Road
- Railroad
- River or Pond
- Highway
- Smelter/Tailing Operational Area

N

0 1 2
Miles

Chino Mines Smelter/Tailings RI
Ecological Risk Assessment

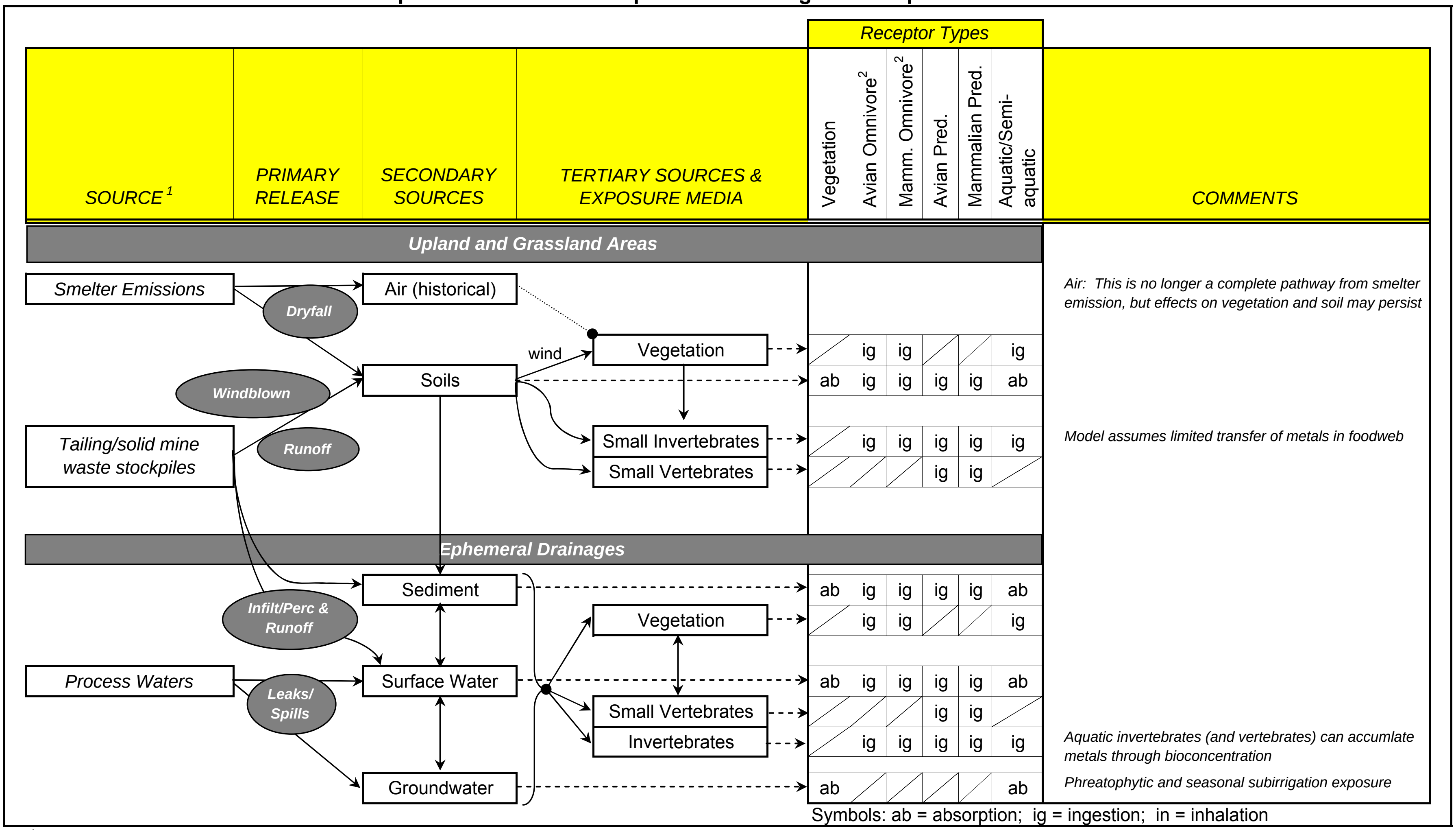
Figure 1.0-1

Chino Mines AOC Investigation Area

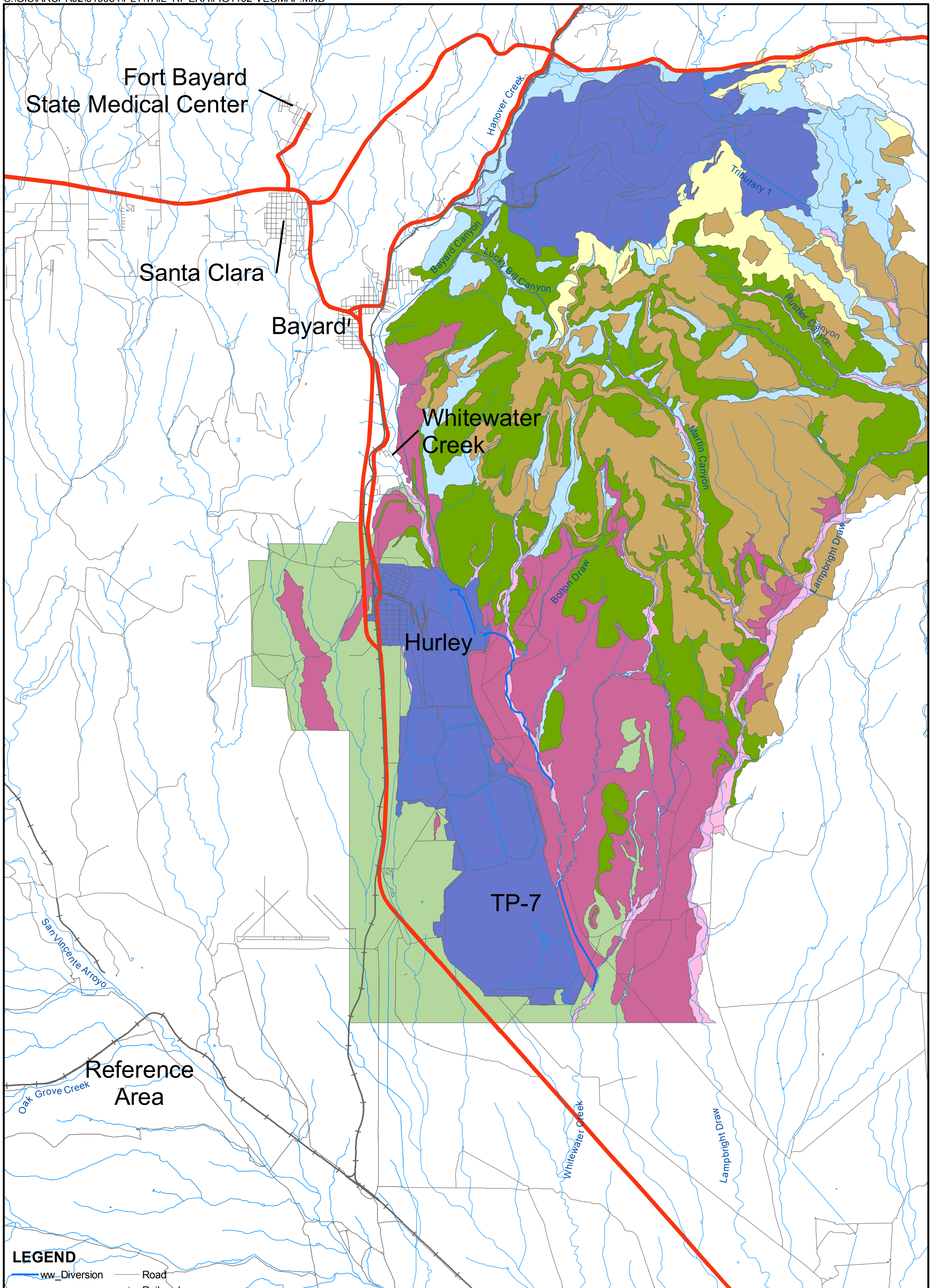
PRJ: 0473-002-900	DATE: April 3, 2008
REV: 1	BY: RCR CHK: MCL

NEWFIELDS

Figure 1.1-1
Conceptual Site Model for Exposure of Ecological Receptors Chino Mines ERA



[1] Includes CMC and non-CMC historical sources as identified in AOC Background Report and RI Proposals
[2] Includes herbivores and assumes most omnivores do not ingest vertebrate prey



LEGEND

- ww_Diversion
- Road
- Railroad
- River or Pond
- Highway

Vegetation

- Fluvial Forest and Shrubland Alliance
- Mesquite/Mixed Grama Shrubland Alliance
- Mine Facilities/Urban
- Ponderosa Pine-Oak Forest Alliance
- Alligator Juniper-Oak Woodland Alliance
- Mountain Mahogany Shrubland Alliance
- Mixed-Grama Herbacious Alliance
- Alligator Juniper-Oak/Grama Woodland Alliance

N

0 1 2

Miles

Chino Mines Smelter/Tailings RI
Ecological Risk Assessment

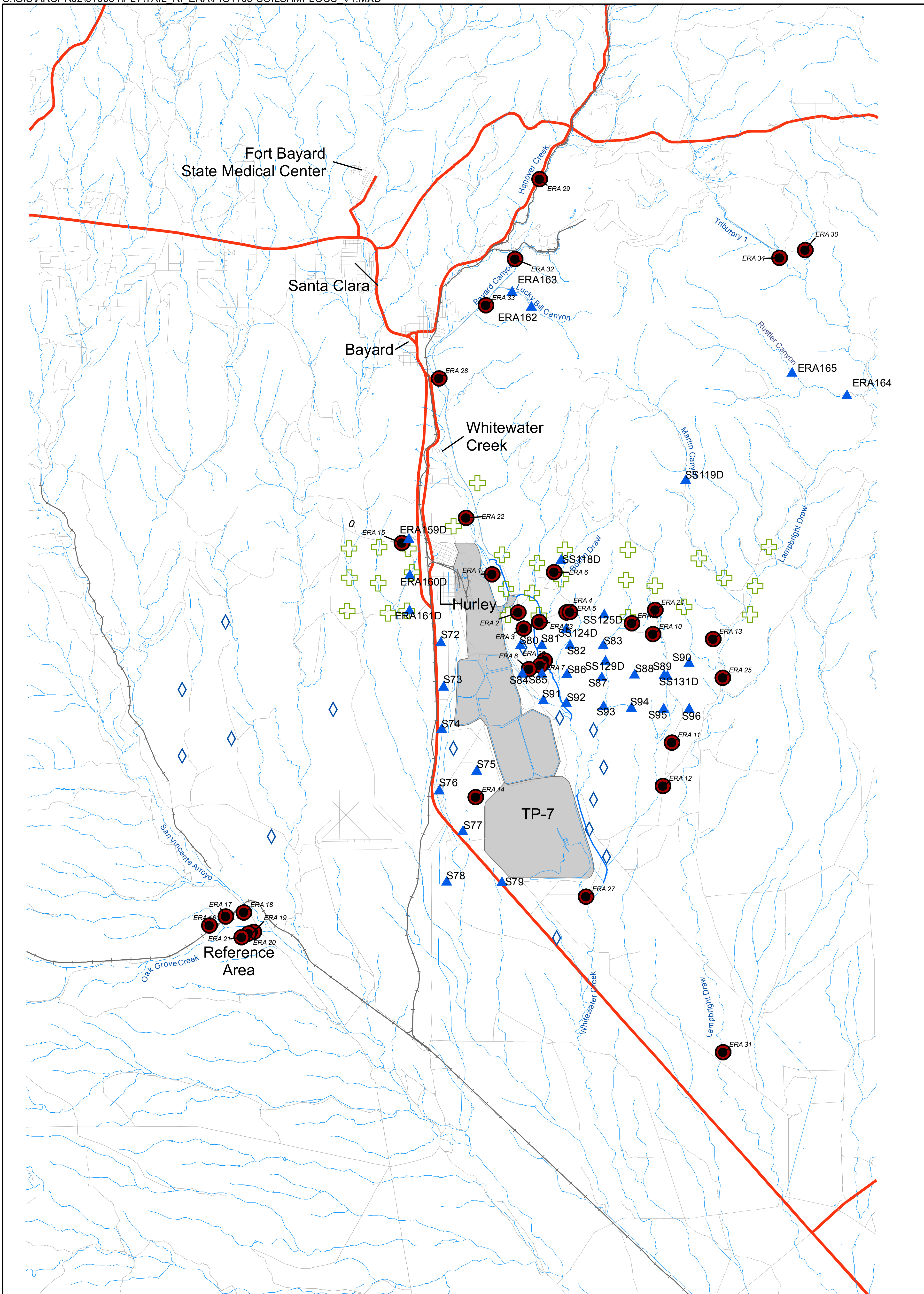
Figure 1.1-2

Vegetation Communities of the Chino Mine AOC Investigation Area (from DBS&A 2000)

PRJ: 0473-002-900	DATE: April 3, 2008
REV: 0	BY: RCR CHK: MCL

NEWFIELDS

S:\GIS\ARCPRJ2\010054\PLT\TAIL_RI_ERA\FIG1103-SOILSAMPLOCS_V1.MXD



LEGEND

- CHINO SMELTER-BRI
- CHINO SMELTER/TAILINGS SOILS RI
- CHINO TAILING-BRI
- ECO RI
- ww_Diversion
- Road
- Railroad
- River or Pond
- Highway
- Smelter/Tailing Operational Area

N

0 1 2

Miles

Note: Location of S57 is approximate

Chino Mines Smelter/Tailings RI
Ecological Risk Assessment

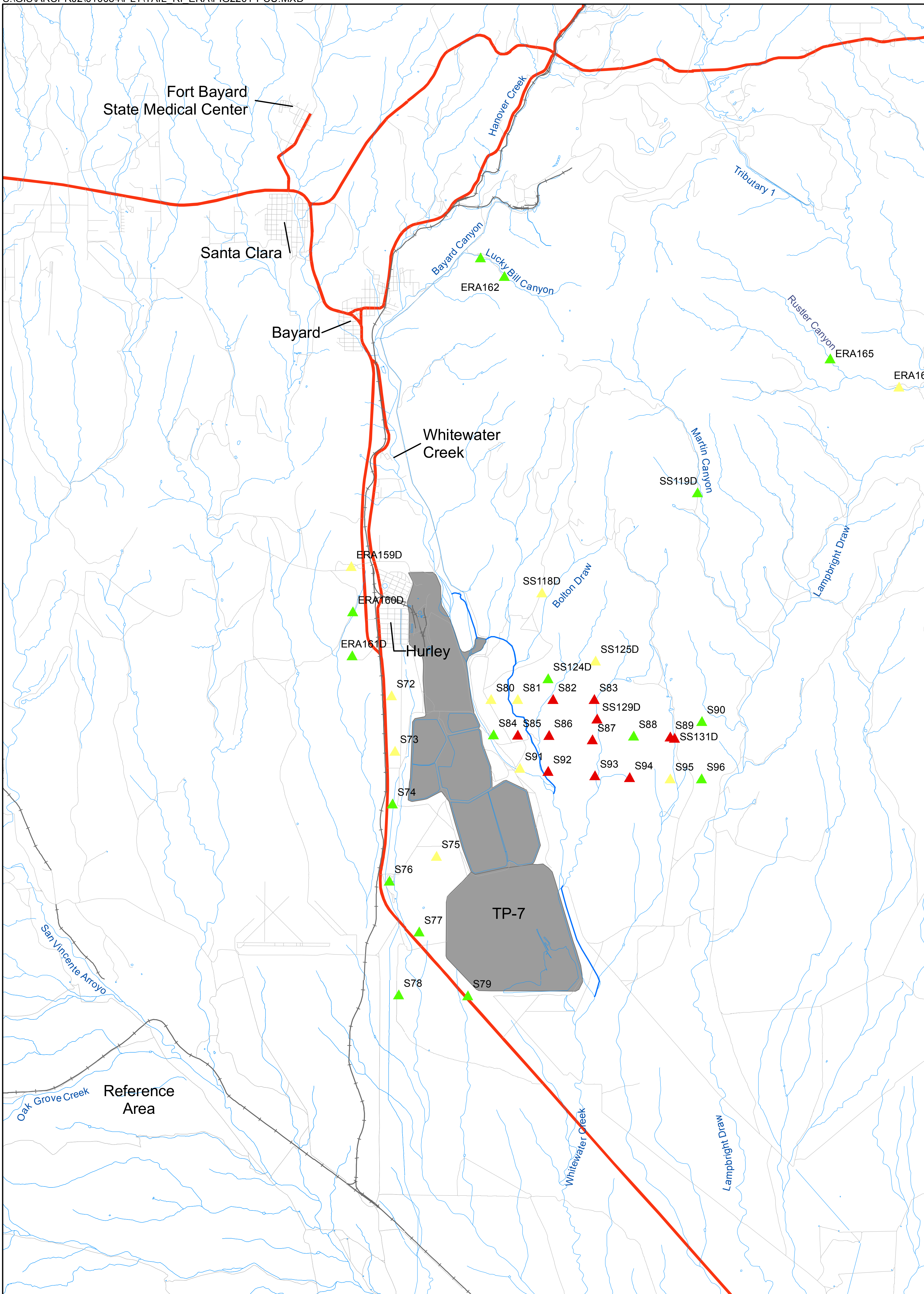
Figure 1.1-3

Soil Sampling Locations Used in the S/TSIU Ecological Risk Assessment

PRJ: 0473-002-900	DATE: April 4, 2008
REV: 3	BY: RCR CHK: JMA

NEWFIELDS

S:\GIS\ARCPRJ2\010054\PLT\TAIL_RI_ERA\FIG2201-PCU.MXD



LEGEND

pCu^{2+}- Shallow Soil Samples (less than 2000 um)

- < 5
- 5 - 7
- > 7
- ww_Diversion
- Road
- Railroad
- River or Pond
- Highway
- Smelter/Tailing Operational Area

Chino Mines Smelter/Tailings RI
Ecological Risk Assessment

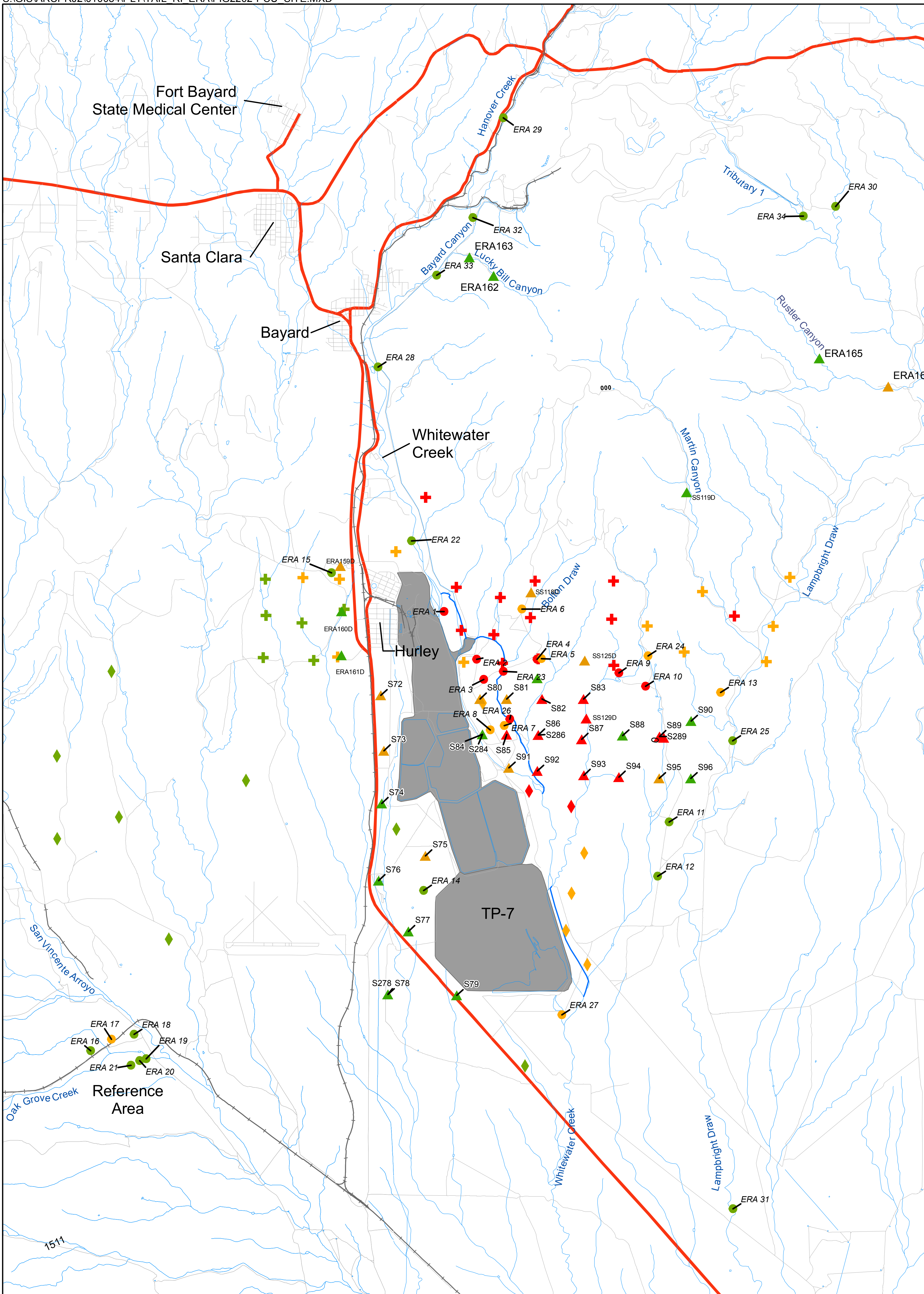
Figure 2.2-1

Predicted pCu^{2+} in
ST/SIU RI Soil Samples

PRJ: 0473-002-900	DATE: April 4, 2008	
REV: 4	BY: RCR	CHK: JMA

NEWFIELDS

S:\GIS\ARCPRJ2\010054\PLT\TAIL_RI_ERA\FIG2202-PCU_SITE.MXD



LEGEND

pCu²⁺ at Sampling Locations

S/TSIU RI	ECO RI	CHINO TAILING-BRI	CHINO SMELTER-BRI
3.5 - 5.0	3.05 -5.00	2.78 - 5.00	3.28- 5.00
5.1 - 7.0	5.01 - 7.00	5.01 - 7.00	5.01 - 7.00
7.1 - 10.3	7.01 - 9.5	7.01 - 9.60	7.01 - 9.28

ww_Diversion

Road

Railroad

River or Pond

Highway

Smelter/Tailing Operational Area

0 1 2 N

Miles

Chino Mines Smelter/Tailings RI

Ecological Risk Assessment

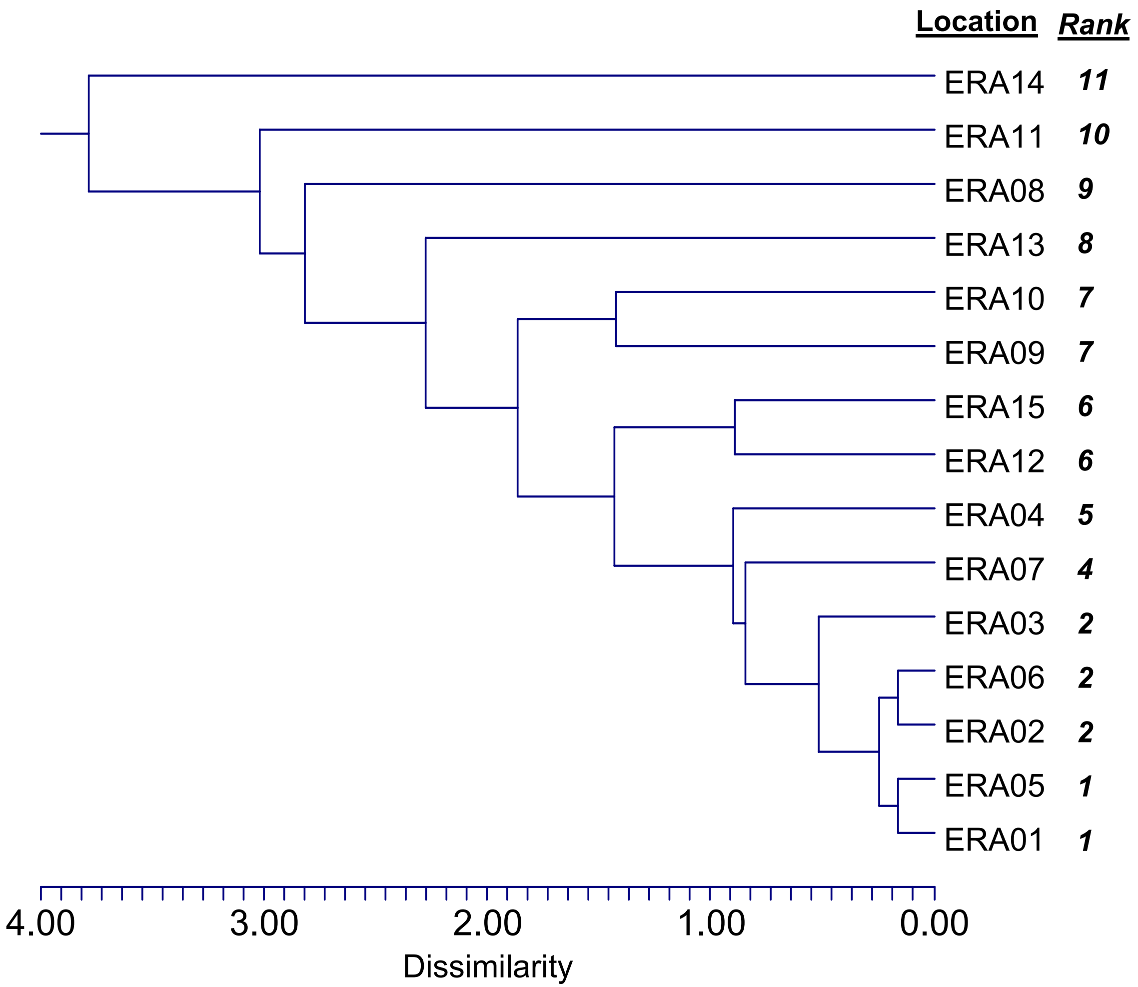
Figure 2.2-2

Predicted pCu^{2+} in Site Soil Samples

PRJ: 0473-002-900	DATE: April 4, 2008	
REV: 3	BY: RCR	CHK: JMA

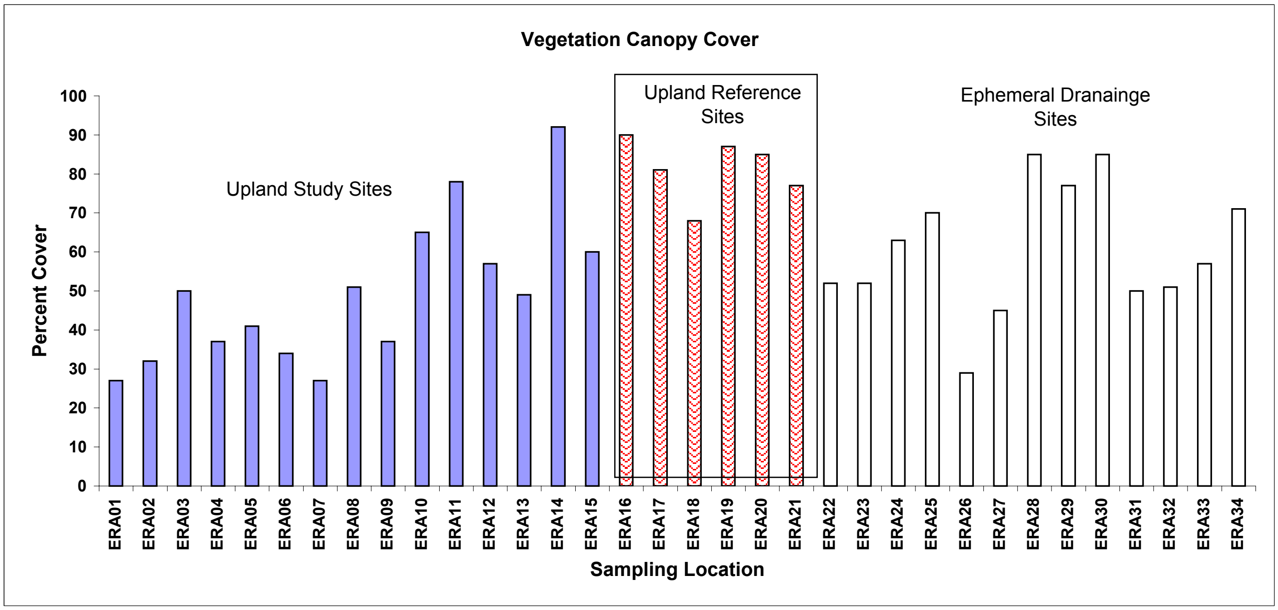
NEWFIELDS

Figure 2.3-1
Hierarchical Clustering Analysis For Upland Study Locations[1]



[1]Analysis performed using top-ten most abundant species in Upland Study Area locations.

Figure 2.3-2
Canopy Cover and Vegetation Richness at ERA Sampling Locations



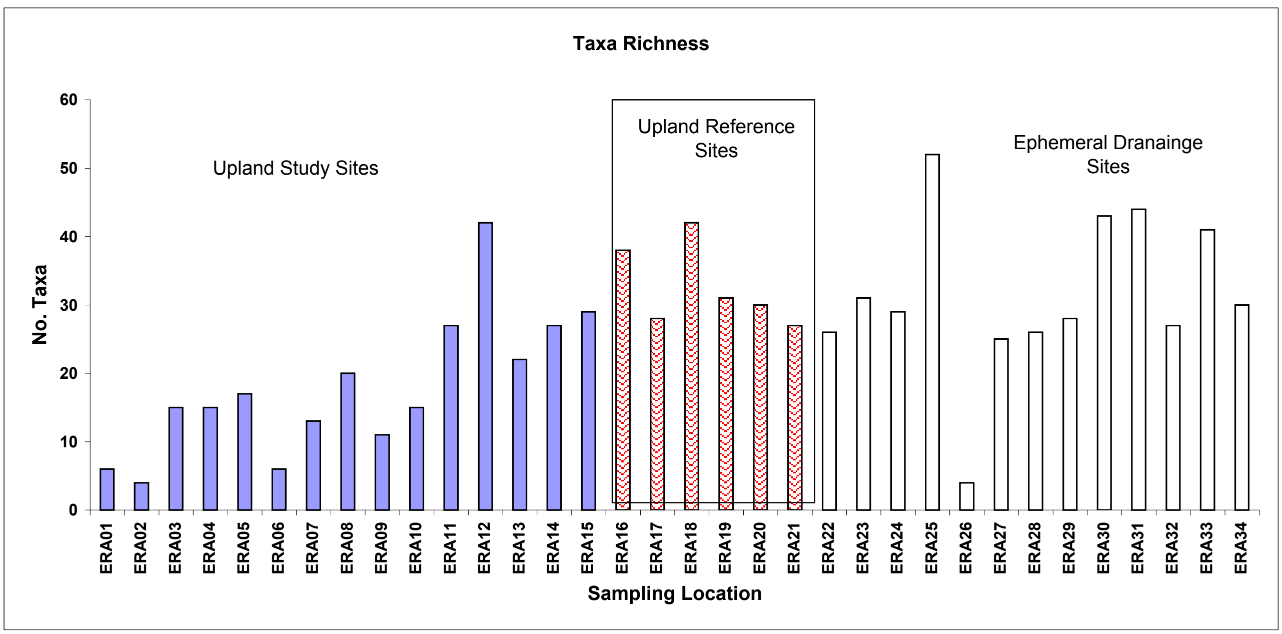
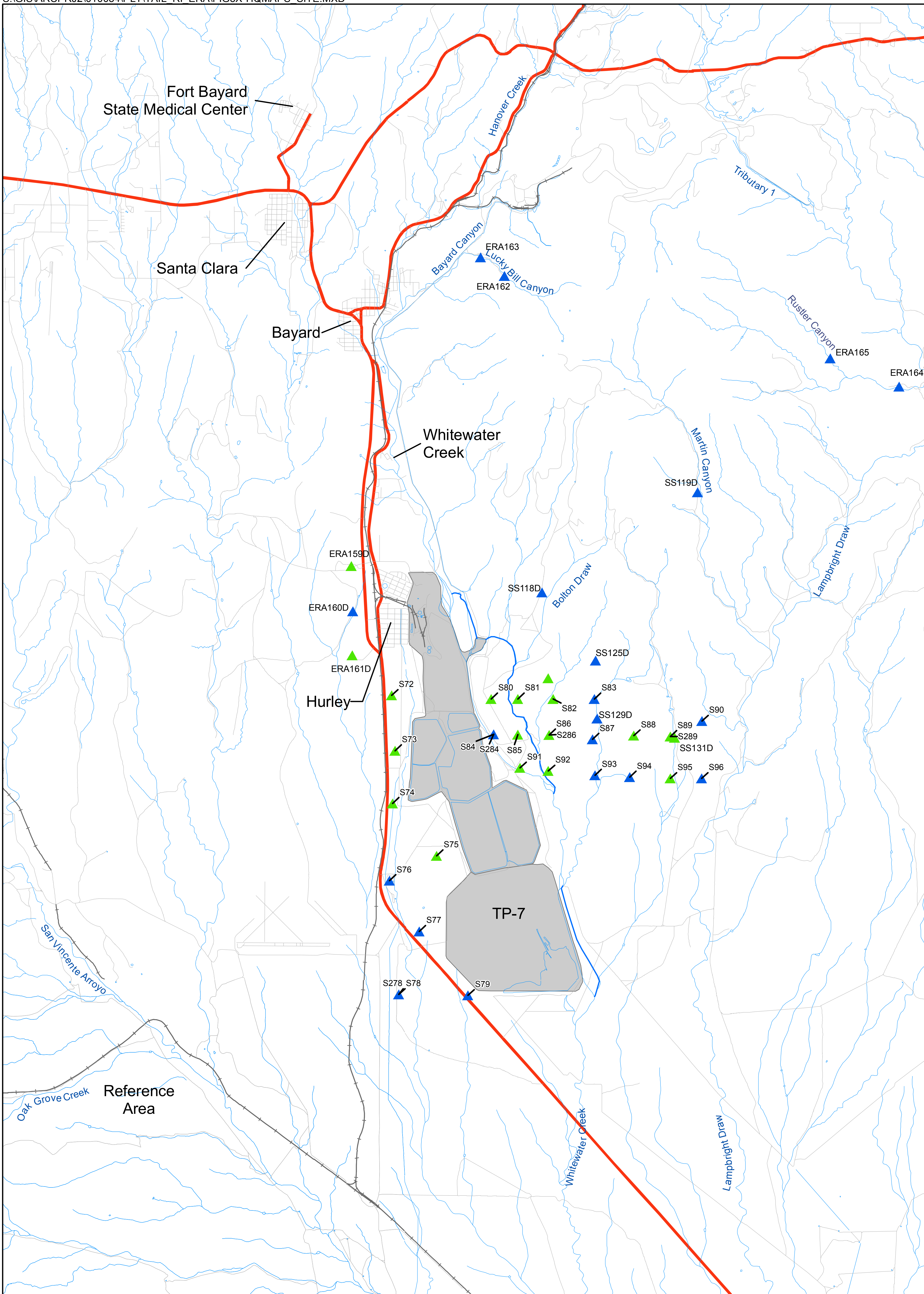


Figure 2.3-3
Phase I Alfalfa Toxicity Testing Results

2.2-7-9.xls
10/2/2003

Figure 2.3-4
Phase I Ryegrass Toxicity Testing Results

S:\GIS\ARCPRJ2\010054\PLT\TAIL_RI_ERA\FIG3X-HQMAPS_SITE.MXD



LEGEND

S/TSIU Soils
- 0 - 0.99
- 1 - 4.99
- 5 - 9.99
- > 9.99

- Road
- Railroad
- River or Pond
- Highway
- Smelter/Tailing Operational Area

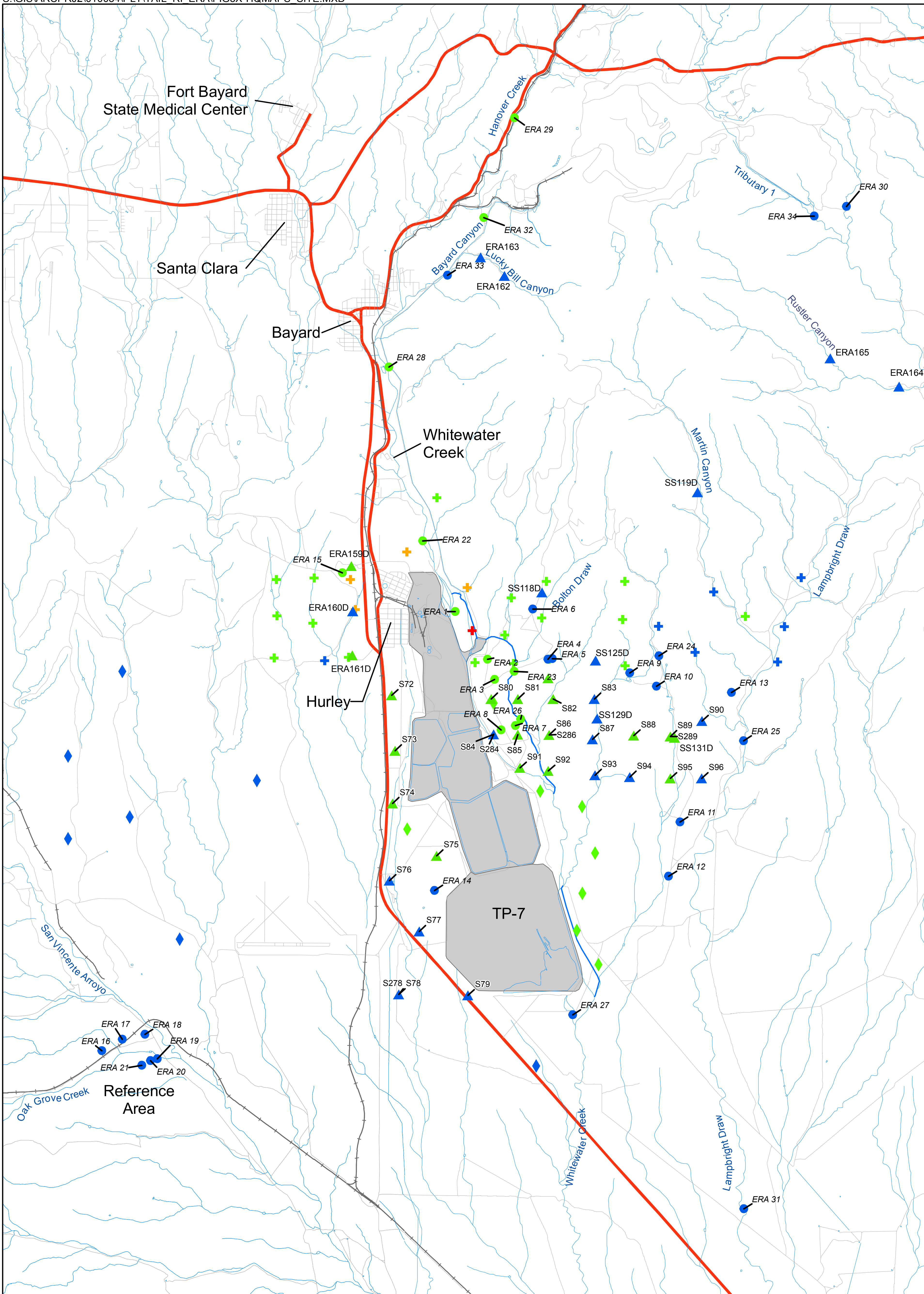
Chino Mines Smelter/Tailings RI
Ecological Risk Assessment

Figure 3.2-1
Hazard Quotient Summary
Using S/STSIU RI Shallow Soil Data (<2,500 um)
Small Ground-feeding Bird
Copper: LOAEL
50% Bioavailability from Soil (SSL = 402 mg/kg)

PRJ: 0473-002-900	DATE: April 4, 2008
REV: 3	BY: RCR CHK: JMA

NEWFIELDS

S:\GIS\ARCPRJ2\010054\PLT\TAIL_RI_ERA\FIG3X-HQMAPS_SITE.MXD



LEGEND

S/TSIU Soils	HQ-ECO RI	HQ-SMELTER BRI	HQ-TAILING BRI
▲ 0 - 0.99	● 0 - 0.99	✚ 0 - 0.99	◆ 0 - 0.99
▲ 1 - 4.99	● 1 - 4.99	✚ 1 - 4.99	◆ 1 - 4.99
▲ 5 - 9.99	● 5 - 9.99	✚ 5 - 9.99	◆ 5 - 9.99
▲ > 9.99	● > 9.99	✚ > 9.99	◆ > 9.99

Road
Railroad
River or Pond
Highway
Smelter/Tailing Operational Area

N

0 1
Miles

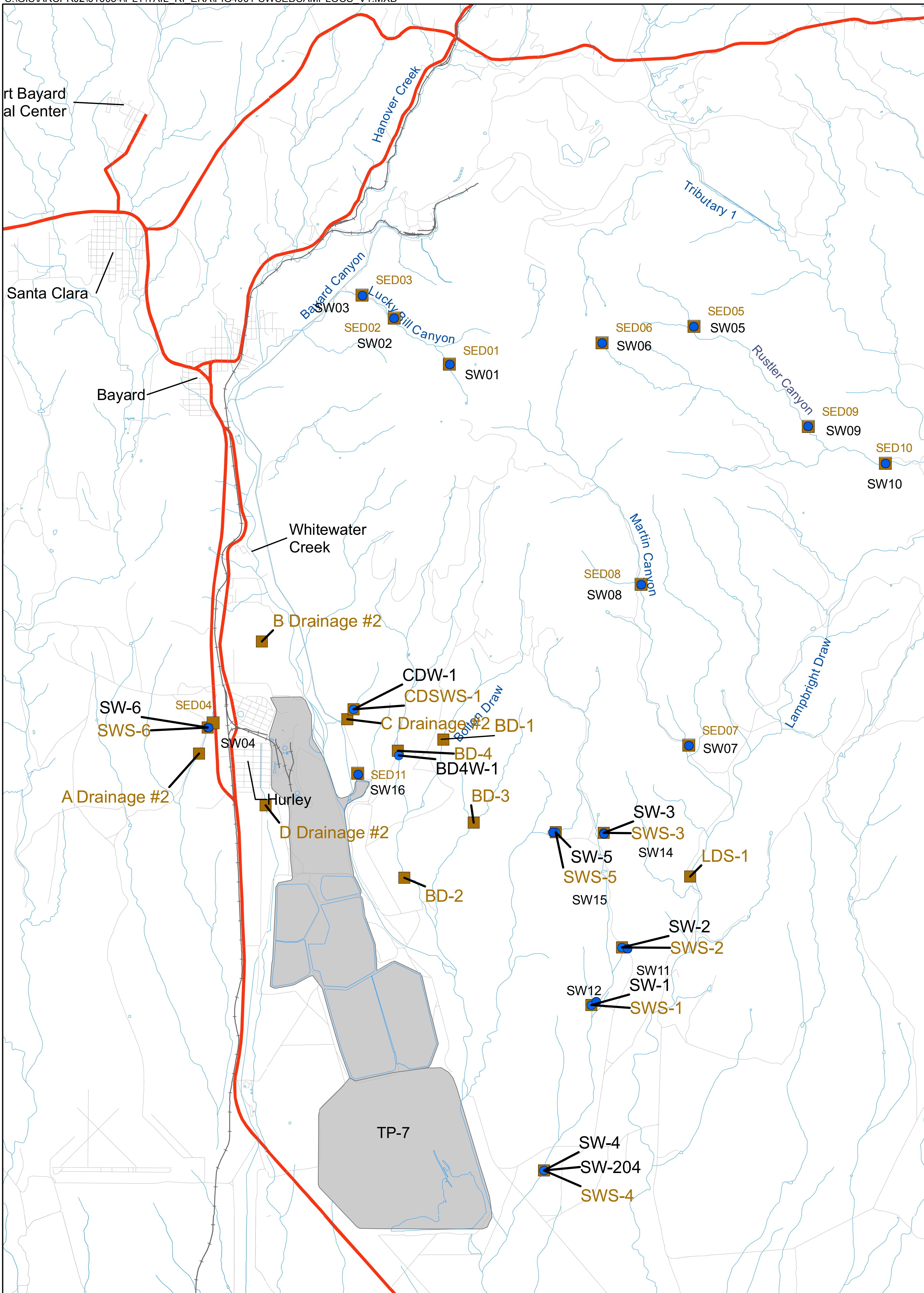
Chino Mines Smelter/Tailings RI
Ecological Risk Assessment

Figure 3.2-2
Hazard Quotient Summary
Using All S/STSIU Shallow Soil Data (<2,500 um)
Small Ground-feeding Bird
Copper: LOAEL
50% Bioavailability from Soil (SSL = 402 mg/kg)

PRJ: 0473-002-900	DATE: April 4, 2008	
REV: 3	BY: RCR	CHK: JMA

NEWFIELDS

S:\GIS\ARCPRJ2\010054\PLT\TAIL_RI_ERA\FIG4001-SWSEDSAMPLOCS_V1.MXD



LEGEND

- Sediment Samples
- Surface Water Samples
- Smelter/Tailing Operational Area
- Road
- Railroad
- River or Pond
- Highway

N

0 1 2

Miles

Chino Mines Smelter/Tailings RI

Ecological Risk Assessment

Figure 4.0-1

Surface Water and Sediment Sampling Locations from the Smelter/Tailings IU RI

PRJ: 0473-002-900	DATE: April 4, 2008
REV: 3	BY: RCR CHK: JMA

NEWFIELDS

APPENDIX A
Smelter Tailings Investigation Unit Data

Table A-1
S/TSIU IU Sample Locations
Chino Mines S/TSIU Ecological Risk Assessment

Name	Easting	Northing	Media	Comment
SHALLOW SOIL SAMPLES (<2500 um)				
S72	2,632,139.18	611,902.43	soil	
S73	2,632,378.89	607,892.35	soil	
S74	2,632,216.30	604,073.54	soil	
S75	2,635,391.26	600,284.04	soil	
S76	2,631,986.85	598,479.72	soil	
S77	2,634,139.92	594,805.32	soil	
S78	2,632,655.47	590,227.31	soil	
S278			soil	Duplicate of S78
S79	2,637,659.38	590,163.69	soil	
S80	2,639,342.19	611,644.49	soil	
S81	2,641,276.21	611,644.49	soil	
S82	2,643,832.48	611,644.49	soil	
S83	2,646,833.89	611,644.49	soil	
S84	2,639,524.94	609,070.70	soil	
S284			soil	Duplicate of S84
S85	2,641,276.21	609,053.37	soil	
S86	2,643,554.30	609,040.57	soil	
S286			soil	Duplicate of S84
S87	2,646,702.12	608,718.74	soil	
S88	2,649,674.25	608,982.06	soil	
S89	2,652,338.92	608,923.54	soil	
S289			soil	Duplicate of S89
S90	2,654,619.67	610,033.02	soil	
S91	2,641,432.26	606,644.34	soil	
S92	2,643,492.14	606,422.03	soil	
S93	2,646,863.17	606,114.83	soil	
S94	2,649,396.07	605,980.77	soil	
S95	2,652,324.28	605,880.77	soil	
S96	2,654,606.51	605,880.77	soil	
ERA159D	2629231.843	621281.561	soil	
ERA160D	2629323.495	617981.858	soil	
ERA161D	2629297.333	614800.497	soil	
ERA162	2640321.57	642299.48	soil	
ERA163	2638580.32	643634.28	soil	
ERA164	2668.911.41	634282.69	soil	
ERA165	2663927.29	636311.45	soil	
SS118D	2643030.463	619356.814	soil	
SS119D	2654304.916	626607.365	soil	
SS124D	2643480.996	613136.726	soil	
SS125D	2646924.195	614418.206	soil	
SS129D	2647038.426	610225.687	soil	
SS131D	2652641.972	608828.178	soil	
SEDIMENT SAMPLES				
A Drainage #2	2,629,280.00	617,595.00	sediment	Composite of drainage transect
B Drainage #2	2,632,853.00	623,977.00	sediment	Composite of drainage transect
C Drainage #2	2,637,726.00	619,539.00	sediment	Composite of drainage transect
D Drainage #2	2,633,066.00	614,629.00	sediment	Composite of drainage transect
BD1-Drainage	2,640,988.00	610,503.00	sediment	Composite of drainage transect
BD2-Drainage	2,644,948.00	613,654.00	sediment	Composite of drainage transect
BD3-Drainage	2,640,617.00	617,743.00	sediment	Composite of drainage transect
BD4-Drainage	2,629,280.00	617,595.00	sediment	Composite of drainage transect
CDSWS-1	2,638,080.28	620,115.63	sediment	
LDS-1	2,657,294.35	610,582.71	sediment	

Table A-1
S/TSIU IU Sample Locations
Chino Mines S/TSIU Ecological Risk Assessment

Name	Easting	Northing	Media	Comment
SWS-1	2,651,659.31	603,246.62	sediment	
SWS-2	2,653,402.85	606,529.34	sediment	
SWS-3	2,652,358.03	613,063.05	sediment	
SWS-4	2,648,941.13	593,816.09	sediment	
SWS-5	2,649,624.73	613,092.94	sediment	
SWS-6	2,629,769.75	619,072.65	sediment	
SED01	2643556.326	639791.489	sediment	
SED02	2640420.344	642421.177	sediment	
SED03	2638576.411	643722.973	sediment	
SED04	2630082.296	619333.735	sediment	
SED05	2657509.344	641945.635	sediment	
SED06	2652272.268	641006.774	sediment	
SED07	2657217.993	618056.928	sediment	
SED08	2654491.07	627238.192	sediment	
SED09	2664029.9	636232.927	sediment	
SED10	2668629.984	627615.743	sediment	
SED11	2638328.309	616453.052	sediment	
SURFACE WATER SAMPLES				
BD4W-1	2,640,658.54	617,488.62	water	Surface water in drainage
CDW-1	2,638,080.28	620,115.63	water	Surface water in drainage
SW-1	2,651,659.31	603,246.62	water	
SW-2	2,653,402.85	606,529.34	water	
SW-3	2,652,358.03	613,063.05	water	
SW-4	2,648,941.13	593,816.09	water	
SW-204			water	Duplicate of SW-4
SW-5	2,649,624.73	613,092.94	water	
SW-6	2,629,769.75	619,072.65	water	
SW01	2643579.365	639794.08	Water	
SW02	2640397.108	642412.031	Water	
SW03	2638592.602	643715.927	Water	
SW04	2629815.052	619062.874	Water	
SW05	2657502.594	641939.277	Water	
SW06	2652272.268	641006.774	Water	
SW07	2657217.895	618053.651	Water	
SW08	2654487.596	627231.735	Water	
SW09	2664017.478	636256.261	Water	
SW10	2668623.43	627615.939	Water	
SW11	2653725.703	606453.623	Water	
SW12	2651929.835	603433.522	Water	
SW13	2651929.835	603433.522	Water	
SW14	2652379.861	613011.941	Water	
SW15	2649463.063	613099.077	Water	
SW16	2638349.586	616396.647	Water	

Data source: Smelter and Talings Soils Investigation Unit RI Report (SRK, 2006)
Soil samples S59 through S63 were not considered in this report since they were located within
the Smelter Operational Area

Table A-2
Additional Data Used in the S/TSIU Ecological Risk Asessment
Chino Mines S/TSIU Ecological Risk Assessment

Name	Easting	Northing	Media	Data Source
SOIL SAMPLES				
ERA 1	2636736.5	617972.43	Soil	ECO RI
ERA 10	2651320.25	612553.37	Soil	ECO RI
ERA 11	2653028.5	602716.06	Soil	ECO RI
ERA 12	2652202.5	598790.62	Soil	ECO RI
ERA 13	2656762.75	612106.81	Soil	ECO RI
ERA 14	2635249.5	597768.5	Soil	ECO RI
ERA 15	2628575.4	620786.59	Soil	ECO RI
ERA 16	2611136.75	586145.43	Soil	ECO RI
ERA 17	2612630.75	586974.06	Soil	ECO RI
ERA 18	2614268.25	587335.12	Soil	ECO RI
ERA 19	2615160	585564.12	Soil	ECO RI
ERA 2	2639087	614506.81	Soil	ECO RI
ERA 20	2614670.5	585436.5	Soil	ECO RI
ERA 21	2614047.75	585099.93	Soil	ECO RI
ERA 22	2634381.78	623081.62	Soil	ECO RI
ERA 23	2641017	613644.75	Soil	ECO RI
ERA 24	2651501.25	614747.5	Soil	ECO RI
ERA 25	2657630	608597.93	Soil	ECO RI
ERA 26	2641490.25	610166.62	Soil	ECO RI
ERA 27	2645254.25	588757.56	Soil	ECO RI
ERA 28	2631937.27	635692.71	Soil	ECO RI
ERA 29	2641025.01	653750.75	Soil	ECO RI
ERA 3	2639598.5	613062.43	Soil	ECO RI
ERA 30	2665088.5	647315.31	Soil	ECO RI
ERA 31	2657662.25	574692.18	Soil	ECO RI
ERA 32	2638816.03	646514.2	Soil	ECO RI
ERA 33	2636186.52	642326.23	Soil	ECO RI
ERA 34	2662757.5	646629.37	Soil	ECO RI
ERA 4	2643462	614512.75	Soil	ECO RI
ERA 5	2643776.25	614546.93	Soil	ECO RI
ERA 6	2642362.75	618149.31	Soil	ECO RI
ERA 7	2641096.5	609705.87	Soil	ECO RI
ERA 8	2640075.75	609383.68	Soil	ECO RI
ERA 9	2649387.25	613515.81	Soil	ECO RI
U04-1001	2637630	619720.5	Soil	CHINO SMELTER-BRI
U04-1002	2637989.25	616607	Soil	CHINO SMELTER-BRI
U04-1003	2638171.25	614282.18	Soil	CHINO SMELTER-BRI
U04-1004	2640347	616287.62	Soil	CHINO SMELTER-BRI
U04-1007	2643338.75	620170.87	Soil	CHINO SMELTER-BRI
U04-1008	2640806.75	618974.62	Soil	CHINO SMELTER-BRI
U04-1009	2642999	617513.87	Soil	CHINO SMELTER-BRI
U04-1010	2643547.25	614531.37	Soil	CHINO SMELTER-BRI
U04-1011	2640965.5	614224.5	Soil	CHINO SMELTER-BRI
U04-1012	2651468	616925	Soil	CHINO SMELTER-BRI
U04-1013	2648869.25	617419.18	Soil	CHINO SMELTER-BRI

Table A-2
Additional Data Used in the S/TSIU Ecological Risk Asessment
Chino Mines S/TSIU Ecological Risk Assessment

Name	Easting	Northing	Media	Data Source
U04-1014	2649020.75	620167.62	Soil	CHINO SMELTER-BRI
U04-1015	2654129.75	615018.31	Soil	CHINO SMELTER-BRI
U04-1016	2649041.5	614062.81	Soil	CHINO SMELTER-BRI
U04-1017	2655470	619400.87	Soil	CHINO SMELTER-BRI
U04-1018	2661795	620439	Soil	CHINO SMELTER-BRI
U04-1019	2660583.75	616899.37	Soil	CHINO SMELTER-BRI
U04-1020	2657765.25	617632.5	Soil	CHINO SMELTER-BRI
U04-1021	2660091.5	614323.31	Soil	CHINO SMELTER-BRI
U04-1022	2635409	626224.43	Soil	CHINO SMELTER-BRI
U04-1023	2633245.25	622309.18	Soil	CHINO SMELTER-BRI
U04-1024	2629164	620299.68	Soil	CHINO SMELTER-BRI
U04-1025	2629508	618136	Soil	CHINO SMELTER-BRI
U04-1028	2629019.5	614661.06	Soil	CHINO SMELTER-BRI
U04-1029	2627301	614413.43	Soil	CHINO SMELTER-BRI
U04-1030	2626437.5	617144.62	Soil	CHINO SMELTER-BRI
U04-1031	2626515.5	620408.5	Soil	CHINO SMELTER-BRI
U04-1032	2623789.5	620305.5	Soil	CHINO SMELTER-BRI
U04-1033	2623832.75	617667.81	Soil	CHINO SMELTER-BRI
U04-1034	2623635.25	614629.43	Soil	CHINO SMELTER-BRI
U06-3001	2633270.75	602196.81	Soil	CHINO TAILING-BRI
U06-3003	2642599	585043.56	Soil	CHINO TAILING-BRI
U06-3007	2639534.75	611335.93	Soil	CHINO TAILING-BRI
U06-3008	2642887	604970.93	Soil	CHINO TAILING-BRI
U06-3012	2645548	594868.87	Soil	CHINO TAILING-BRI
U06-3013	2647115	592399.87	Soil	CHINO TAILING-BRI
U06-3015	2608687.25	607511.87	Soil	CHINO TAILING-BRI
U06-3016	2608704.5	601502.87	Soil	CHINO TAILING-BRI
U06-3018	2645936	603851.93	Soil	CHINO TAILING-BRI
U06-3020	2646878	600474.93	Soil	CHINO TAILING-BRI
U06-3022	2645956	597545.87	Soil	CHINO TAILING-BRI
U06-3024	2622372.5	605734.87	Soil	CHINO TAILING-BRI
U06-3026	2612624.5	613627.93	Soil	CHINO TAILING-BRI
U06-3028	2613165.5	603090.87	Soil	CHINO TAILING-BRI
U06-3030	2616782.5	594224.56	Soil	CHINO TAILING-BRI

Table A-3 Results for Soil Samples Used in the S/TSIU Ecological Risk Assessment

Parameter	S72 11/4/2004	S73 11/4/2004	S74 11/1/2004	S75 11/1/2004	S76 11/1/2004	S77 11/1/2004	S78 11/4/2004	S278[1] 11/4/2004	S79 11/4/2004	S80 11/10/2004
Aluminum	7,660	7,440	6,410	9,450	8,380	6,470	6,880	6,590	7,440	7,550
Antimony	< 0.76	< 0.76	< 0.76	< 0.76	< 0.76	< 0.76	< 0.76	< 0.76	< 0.76	< 0.76
Arsenic	2.3	2.1	1.6	1.7	2.6	1.3	1.5	1.6	1.4	B 1.1
Barium	163	154	134	167	656	126	120	120	114	154
Beryllium	B 0.51	B 0.51	B 0.48	B 0.62	B 0.91	B 0.5	B 0.52	B 0.49	B 0.56	B 0.5
Boron	B 1.6	< 1.5	B 1.8	< 1.5	< 1.5	< 1.5	< 1.5	< 1.5	< 1.5	< 1.5
Cadmium	B 1.7	1.4	0.72	0.89	0.91	0.52	0.5	0.52	0.37	B 0.58
Calcium	83,600	68,300	51,100	60,200	53,200	39,000	29,600	27,600	15,600	5,950
Chromium	8.2	8.1	7.3	9.3	8.9	8	8.5	7.7	8.6	7.9
Cobalt	B 6.5	B 9.4	B 6	10.5	B 7	B 5.3	B 5.1	B 5	B 5.1	12.6
Copper	1,160	1,290	529	940	278	267	207	211	157	1440
Iron	9,670	12,900	9,780	15,800	11,700	9,710	10,900	10,100	11,100	17,200
Lead	32	30.5	21.5	23.7	20.8	19.5	18.6	19.1	20.6	14.9
Magnesium	2,860	2,910	2,610	3,750	4,180	2,580	2,540	2,480	2,580	2,100
Manganese	349	362	316	398	439	302	297	287	313	266
Mercury	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Molybdenum	9.2	17.3	7.3	9.8	4.6	4.7	4.1	4.2	3.2	18.4
Nickel	B 7.7	B 7.1	B 6.1	B 7.7	10.4	B 5.6	B 5.6	B 5.3	B 6.1	8.2
pH	7.85	7.72	7.71	7.75	7.78	7.86	7.79	7.84	7.95	6.69
Potassium	2440	2450	1740	3290	1690	1630	1,790	1,740	2,310	1,930
Selenium	B < 0.80	< 0.80	< 0.80	< 0.80	< 0.80	< 0.80	< 0.80	< 0.8	< 0.80	B < 0.80
Silver	B 0.09	B < 0.06	B < 0.06	B < 0.06	B < 0.06	B < 0.06	B < 0.06	B < 0.06	B < 0.06	B 0.09
Sodium	B 73	66.1	B 58.4	78.2	B 66	69.1	52.3	51.3	B 49.9	84
Thallium	1.3	< 0.74	1.2	< 0.74	0.78	< 0.74	< 0.74	< 0.74	1.1	< 0.74
TOC	1.28	1.6	1.07	1.56	0.98	0.85	0.97	0.96	0.9	0.91
Vanadium	12.7	12.8	13.1	16.7	22.8	14.1	17.7	15.8	17	16
Zinc	69.2	64	53.6	63.1	82.5	58.6	47.3	48.6	47	36.5
AOC Identifier	U04-1106	U04-1107	U04-1108	U04-1109	U04-1110	U04-1111	U04-1112	--	U04-1113	U04-1114
Laboratory	SVL	SVL	SVL	SVL	SVL	SVL	SVL	SVL	SVL	SVL
Laboratory Identifier	S427625	S427622	S427620	S427626	S427624	S427623	S427621	S427628	S427627	S427742

Notes:

(1) Duplicate sample. Duplicate sample follows the primary sample

-- = not analyzed or not applicable

< = less than the Method Detection Limit

mg/kg = milligrams per kilogram.

TOC = total organic carbon

SVL = SVL Analytical, Inc. of Kellogg, Idaho

B = laboratory identifier for estimated value

Table A-3 Results for Soil Samples Used in the S/TSIU Ecological Risk Assessment

Parameter	S81 11/10/2004	S82 11/10/2004	S83 11/12/2004	S84 11/10/2004	S284[1] 11/10/2004	S85 11/10/2004	S86 11/17/2004	S286[1] 11/17/2004	S87 11/12/2004	S88 11/12/2004	S89 11/12/2004	S289[1] 11/12/2004
Aluminum	12,100	5,000	8,240	2,810	2,200	8,260	6,930	6,850	7,980	9,190	7,610	8,030
Antimony	B 1.2	B 0.89	< 0.76	B 1.5	< 0.76	< 0.76	< 0.76	< 0.76	< 0.76	< 0.76	< 0.76	< 0.76
Arsenic	B 2.5	B 2.2	1.9	B 0.45	B 0.44	B 1.4	2.4	2.7	1.4	1.2	1.8	1.4
Barium	199	102	76.7	117	113	161	113	107	80.4	157	109	117
Beryllium	B 0.75	B 0.43	B 0.48	B 0.17	B 0.15	B 0.41	B 0.35	B 0.34	B 0.71	B 0.69	B 0.63	B 0.68
Boron	< 1.5	< 1.5	< 1.5	< 1.5	< 1.5	< 1.5	< 1.5	< 1.5	< 1.5	B 2.4	< 1.5	< 1.5
Cadmium	B 0.21	B 0.23	0.14	B 0.14	B 0.14	B 0.17	0.26	0.15	0.3	0.38	0.3	0.33
Calcium	7,700	B 939	B 553	18,500	15,300	1,390	1,060	1,120	1,090	34,600	1,670	1,770
Chromium	9.8	5.8	6.4	3.5	3	9.4	6.2	6.1	7.2	5.7	7.2	7.6
Cobalt	13.4	B 3.9	B 3.4	B 6.4	B 5.8	B 5	B 5	B 5.1	B 5.9	B 5.8	B 5.7	B 6
Copper	875	455	358	362	316	451	513	507	309	484	399	436
Iron	20,300	12,600	11,400	14,600	14,100	18,500	16,200	16,100	9,290	9,320	9,890	10,500
Lead	15.4	17.3	12.7	4.5	4	11.2	13.4	13.5	9.5	14.8	15.8	17.1
Magnesium	3,290	1,000	1,190	B 902	B 701	1,450	1,330	1,300	1,140	2,390	1,530	1,570
Manganese	409	173	146	95.3	88.2	140	162	142	234	242	242	274
Mercury	B 0.05	B 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Molybdenum	12	10.6	6	36.6	35.8	19.7	10.9	12.2	2	5.8	6	5.6
Nickel	17.3	B 0.96	B 2.9	B 2.2	B 1.3	B 5.6	B 0.76	B 0.87	B 5.4	B 6.4	B 6.3	B 6.5
pH	6.8	3.93	3.96	7.3	7.21	3.88	3.79	3.74	4.33	7.7	4.48	4.43
Potassium	1,940	B 1,120	1,230	B 1,300	B 1,240	1,720	1,330	1,320	1,450	2,920	2,020	2,170
Selenium	< 0.16	0.41	< 1.6	1.3	1.3	< 0.80	< 0.80	< 0.8	< 1.6	< 1.6	< 1.6	< 4
Silver	B < 0.06	B < 0.06	B < 0.06	B < 0.06	B < 0.06	B < 0.06	B < 0.06	B < 0.06	B < 0.06	B < 0.06	B < 0.06	B < 0.06
Sodium	81.6	86.3	68.8	110	B 108	90	129	131	58.1	77.1	53.1	56.2
Thallium	< 0.74	< 0.74	< 0.74	B < 0.74	B 0.78	< 0.74	< 0.74	< 0.74	< 0.74	< 0.74	< 0.74	< 0.74
TOC	1.03	0.82	0.67	0.23	0.24	0.52	1.27	0.92	0.68	1.25	0.79	0.76
Vanadium	30.4	17.6	18.2	8.4	7.4	22.6	20.8	18.8	17.2	12.2	13.7	15.2
Zinc	36.3	14.6	17.7	14.3	11.8	20.2	19.3	19.5	21.1	24.9	21.7	23.1
AOC Identifier	U04-1115	U04-1116	U04-1117	U04-1118	--	U04-1119	U04-1120	--	U04-1121	U04-1122	U04-1123	--
Laboratory	SVL	SVL	SVL	SVL	SVL	SVL	SVL	SVL	SVL	SVL	SVL	SVL
Laboratory Identifier	S427744	S427743	S428501	S427741	S427740	S427745	S428740	S428742	S428503	S428502	S428506	S428505

Notes:

(1) Duplicate sample. Duplicate sample follows the primary sample

-- = not analyzed or not applicable

< = less than the Method Detection Limit

mg/kg = milligrams per kilogram.

TOC = total organic carbon

SVL = SVL Analytical, Inc. of Kellogg, Idaho

B = laboratory identifier for estimated value

Table A-3 Results for Soil Samples Used in the S/TSIU Ecological Risk Assessment

Parameter	S90 11/17/2004	S91 11/17/2004	S92 11/17/2004	S93 11/17/2004	S94 11/12/2004	S95 11/12/2004	S96 11/17/2004	ERA159D 7/16/2006	ERA160D 7/16/2006	ERA161D 7/16/2006	ERA162 7/11/2006	ERA163 7/14/2--6
Aluminum	15,700	6,000	11,700	11,500	7,660	9,320	10,700	19700	6170	11400	6,190	6,870
Antimony	< 0.76	< 0.76	< 0.76	< 0.76	< 0.76	< 0.76	< 0.76	<0.58	<0.58	0.77 B	<0.58	<0.58
Arsenic	2.6	1.8	2.2	2.5	1.1	2.6	2.1	3.4	0.95	2.2	1.9	0.92
Barium	204	118	156	117	111	127	147	161	62.8	149	99.6	100
Beryllium	B 0.96	B 0.4	B 0.9	B 0.73	B 0.77	B 0.63	B 0.82	1.1	0.42	0.67	0.53	0.51
Boron	< 1.5	< 1.5	< 1.5	< 1.5	< 1.5	< 1.5	B 3.4	<1.7	<1.7	<1.7	<1.7	<1.7
Cadmium	0.32	0.25	0.33	0.16	0.15	0.43	0.28	0.61	0.04	0.63	2.6	0.36
Calcium	21,100	16,600	5,970	4,180	1,790	3,990	20,700	7170	1650	60100	3,010	2,750
Chromium	12.4	9.7	10	13.1	6.3	11.1	11.2	25	5.5	17.2	7.8	6.9
Cobalt	B 9.5	16.7	10	B 8.2	B 4.9	11.2	B 7.6	10.4	7.8	7.5	7.5	6.2
Copper	255	926	581	308	313	494	237	809	34.1	556	218	208
Iron	14,800	36,300	15,300	18,500	8,650	15,800	11,700	30100	18400	18800	16,200	12,700
Lead	15.4	9.8	11	11.4	16	17.9	15.5	29.3	7.7	20.8	275	26.5
Magnesium	4,110	2,310	2,880	2,600	1,360	2,270	3,190	3170	2000	3580	1,620	1,750
Manganese	397	280	245	276	268	407	314	456	311	374	680	461
Mercury	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	B 0.05	< 0.05	0.04	<0.017	0.03 B	B 0.03	<0.02
Molybdenum	3	28.3	4	5.3	4.3	5.5	3.4	3.7	0.59 B	3	3.4	7.6
Nickel	14.5	B 3.5	B 7	12	B 5.1	10.8	10.4	16.4	5.2	12.2	6.1	4.7
pH	7.86	7.05	3.78	4.22	4.28	5.96	7.61	7.59	7.6	7.85	6.49	6.95
Potassium	2,830	B 2,110	2,110	2,090	2,690	1,820	2,440	3070	967	2670	1,600	1,800
Selenium	< 1.6	1.2	< 1.6	< 0.8	< 4	< 4	< 1.6	<0.04	0.07 B	<0.04	B 0.17	B 0.14
Silver	B < 0.06	B < 0.06	B < 0.06	B < 0.06	B < 0.06	B < 0.06	B < 0.06	<0.07	<0.07	<0.07	B 0.33	<0.07
Sodium	88.9	113	112	91.6	72.1	76.5	70.3	54.7	139	65.2	61.3	67
Thallium	< 0.74	< 0.74	< 0.74	< 0.74	< 0.74	< 0.74	< 0.74	<0.35	<0.35	<0.35	<0.35	<0.35
TOC	1.65	0.69	0.4	0.76	0.52	1.01	1.39	1.01	0.13	1.13	0.55	1.41
Vanadium	27.6	16.5	22	25.7	13.4	24.6	17	48.6	44.9	33.9	20.5	19.3
Zinc	38.1	38.5	30	29.9	21.1	32.9	35.3	81.1	19.8	57.4	1010	54.1
AOC Identifier	U04-1124	U04-1125	U04-1126	U04-1127	U04-1128	U04-1129	U04-1130	U04-1235	U04-1236	U04-1237	U04-1203	U04-1204
Laboratory	SVL	SVL	SVL	SVL	SVL	SVL	SVL	--	--	--	SVL	SVL
Laboratory Identifier	S428739	S428738	S428741	S428737	S428507	S428504	S428736	--	--	--	S522235	S522233

Notes:

[1] Duplicate sample. Duplicate sample follows the primary sample

-- = not analyzed or not applicable

< = less than the Method Detection Limit

mg/kg = milligrams per kilogram.

TOC = total organic carbon

SVL = SVL Analytical, Inc. of Kellogg, Idaho

B = laboratory identifier for estimated value

Table A-3 Results for Soil Samples Used in the S/TSIU Ecological Risk Assessment

Parameter	ERA164 7/14/2006	ERA165 7/14/2006	SS118D 7/19/2006	SS119D 7/13/2006	SS124D 7/19/2006	SS125D 7/19/2006	SS129D 7/19/2006	SS131D 7/18/2006
Aluminum	6,790	6,980	9160	17500	11000	8350	9950	11200
Antimony	<0.58	<0.58	<0.58	<0.58	<0.58	<0.58	<0.58	<0.58
Arsenic	1.9	1.8	1.5 B	1.5	3.2 B	0.96 B	1.9 B	1.6 B
Barium	74.2	103	91.5	172	144	69.7	86.9	139
Beryllium	1	0.65	0.66	1	0.67	0.82	0.65	0.86
Boron	<1.7	<1.7	<1.7	<1.7	<1.7	<1.7	<1.7	1.9 B
Cadmium	B 0.32	B 0.48	0.26 B	0.29	1	0.25 B	0.1 B	0.62
Calcium	1,980	3,790	987	5910	19800	1370	833	2800
Chromium	6.4	5.2	9.3	18.9	22.4	7.4	11	15.2
Cobalt	5.5	6.3	6.4	12.3	10.3	5.1	4.9	7.5
Copper	136	177	259	125	523	166	337	444
Iron	9,460	10,600	14200	20500	23600	9610	19000	16600
Lead	14.3	15.9	10.2	10.4	16.3	10.6	12.1	18.3
Magnesium	1,690	1,690	1400	6740	2390	1340	1400	2110
Manganese	447	482	302	466	297	339	149	304
Mercury	<0.02	B 0.02	0.02 B	0.02 B	0.03 B	0.02 B	<0.017	0.02 B
Molybdenum	2.7	3.6	2.8	1.6	6.9	1.5	5.9	6.1
Nickel	5.1	3.6	7.9	25.4	17.3	6.5	6.2	11.2
pH	5.62	6.9	4.99	6.1	7.56	5.22	4.07	4.76
Potassium	1,610	1,620	1670	1690	2060	1780	1480	2780
Selenium	<0.04	<0.02	0.18	0.13 B	0.68	0.17	0.48	0.49
Silver	<0.07	<0.07	<0.07	<0.07	<0.07	<0.07	<0.07	0.11 B
Sodium	88.8	61	63.9	234	54.8	69.7	65	68.2
Thallium	B 0.43	B 0.5	0.58 B	<0.35	<0.35	<0.35	<0.35	<0.35
TOC	0.62	2.77	0.32	0.89	1.2	0.37	0.47	1.58
Vanadium	15.9	16.5	30.3	49	52.2	16.9	28.5	26.6
Zinc	29.6	34.9	24.4	31.1	35.4	20.8	23.1	33.4
AOC Identifier	U04-1205	U04-1206	U04-1188	U04-1190	U04-1196	U04-1198	U04-1203	U04-1206
Laboratory	SVL	SVL	--	--	--	--	--	--
Laboratory Identifier	S522458	S522453	--	--	--	--	--	--

Notes:

[1] Duplicate sample. Duplicate sample follows the primary sample

-- = not analyzed or not applicable

< = less than the Method Detection Limit

mg/kg = milligrams per kilogram.

TOC = total organic carbon

SVL = SVL Analytical, Inc. of Kellogg, Idaho

B = laboratory identifier for estimated value

Table A-4 Results of Surface Water Samples Used in the S/TSIU Ecological Risk Assessment

Parameter	BD4W-1 11/20/2004	CDW-1 11/20/2004	SW-1 11/19/2004	SW-2 11/19/2004	SW-3 11/19/2004	SW-4 11/19/2004	SW-204[(1)] 11/19/2004	SW-5 11/20/2004	SW-6 11/21/2004	SW01 7/11/2006
Aluminum, dissolved	0.0561	0.0412	0.0445	0.854	0.0365	0.233	0.0257	0.387	0.0421	<0.0069
Aluminum, total	B 0.145	B 0.0595	10.8	10.8	0.621	31.1	24.6	19.7	1.66	0.535
Antimony, dissolved	< 0.0038	< 0.0038	< 0.0038	< 0.0038	< 0.0038	< 0.0038	< 0.0038	< 0.0038	< 0.0038	<0.0055
Antimony, total	< 0.0038	< 0.0038	< 0.0038	< 0.0038	< 0.0038	< 0.0038	< 0.0038	< 0.0038	< 0.0038	<0.0055
Arsenic, dissolved	< 0.0064	< 0.0064	< 0.0064	< 0.0064	< 0.0064	< 0.0064	0.0064	< 0.0064	< 0.0064	<0.0045
Arsenic, total	< 0.0064	< 0.0064	< 0.0064	< 0.0064	< 0.0064	B 0.0097	B 0.0075	< 0.0064	B 0.0078	<0.0045
Barium, dissolved	0.0238	0.0276	0.0328	0.0413	0.0266	0.0241	0.022	0.0157	0.0677	0.0411
Barium, total	B 0.0248	B 0.0282	B 0.0803	B 0.0926	B 0.0326	B 0.111	B 0.105	B 0.0562	B 0.0886	0.0441
Beryllium, dissolved	< 0.0001	0.00011	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	<0.0002
Beryllium, total	< 0.0001	B 0.00018	B 0.00031	B 0.00027	< 0.0001	B 0.0012	B 0.001	B 0.0008	< 0.0001	<0.0002
Boron, dissolved	0.0126	0.0112	0.0301	0.0226	0.0345	0.0259	0.0263	0.0242	0.0268	0.0095 B
Boron, total	< 0.0077	< 0.0077	B 0.0233	B 0.0157	B 0.0261	< 0.0077	< 0.0077	B 0.0149	B 0.0241	0.0091 B
Cadmium, dissolved	0.0012	0.0015	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	<0.0003
Cadmium, total	0.0013	0.0014	B 0.00011	B 0.00013	< 0.0001	B 0.00017	B 0.00017	B 0.00017	B 0.0003	<0.0003
Calcium, dissolved	19.3	15.5	24.5	21	7.11	15.2	15.5	12.6	33.8	16.6
Calcium, total	19.3	15.2	26.3	22.9	7.41	19.4	19.5	14.4	33.4	16.5
Chromium, dissolved	< 0.0003	< 0.0003	< 0.0003	0.00038	< 0.0003	< 0.0003	< 0.0003	< 0.0003	< 0.0003	<0.0007
Chromium, total	< 0.0003	< 0.0003	0.0056	0.0055	< 0.0003	0.0157	0.0125	0.0085	0.00087	<0.0007
Cobalt, dissolved	0.0021	0.0023	0.0011	0.008	0.0007	0.0074	0.0006	0.0055	0.0037	<0.0002
Cobalt, total	B 0.00052	< 0.0005	B 0.0029	B 0.0022	B 0.0012	B 0.0038	B 0.0034	B 0.002	B 0.0024	<0.0002
Copper, dissolved	0.207	0.327	0.0436	0.0514	0.038	0.0371	0.0338	0.0606	0.0954	0.0153
Copper, total	0.234	0.349	0.205	0.213	0.0557	0.275	0.261	0.267	0.468	0.0265
Iron, dissolved	0.0097	< 0.0059	0.0211	0.469	0.0259	0.147	0.0082	0.335	0.0343	0.0171 B
Iron, total	B 0.0633	< 0.0059	7.63	6.66	0.435	17.1	13.5	10.5	1.81	0.281
Lead, dissolved	< 0.0018	< 0.0018	< 0.0018	< 0.0018	< 0.0018	< 0.0018	< 0.0018	< 0.0018	< 0.0018	<0.0015
Lead, total	< 0.0018	< 0.0018	B 0.0067	B 0.006	< 0.0018	B 0.015	B 0.0123	B 0.0096	B 0.0044	<0.0015
Magnesium, dissolved	4.84	3.53	2.16	2.35	1.77	1.97	2.03	3.66	2.71	6.76
Magnesium, total	B 4.94	B 3.51	B 3.52	B 3.68	B 1.94	6.33	5.52	6.49	B 2.91	6.84
Manganese, dissolved	0.0303	0.0532	0.009	0.0222	0.0194	0.0195	0.0083	0.0259	0.0528	0.0252
Manganese, total	0.0316	0.0499	0.151	0.162	0.0527	0.182	0.168	0.151	0.301	0.0399
Mercury, dissolved	< 0.0167	< 0.0167	< 0.0167	< 0.0167	< 0.0167	< 0.0167	< 0.0167	< 0.0167	< 0.0167	<0.0001
Mercury, total	< 0.0167	< 0.0167	< 0.0167	< 0.0167	< 0.0167	< 0.0167	< 0.0167	< 0.0167	< 0.0167	<0.0001
Molybdenum, dissolved	0.0082	0.0035	0.0143	0.0109	0.0035	0.0048	0.006	0.008	0.0124	0.0021 B
Molybdenum, total	0.0084	B 0.0023	0.0154	0.0123	B 0.0034	0.0077	0.007	0.0118	0.0128	0.0025 B
Nickel, dissolved	0.0026	0.0033	< 0.0017	< 0.0017	< 0.0017	< 0.0017	< 0.0017	< 0.0017	< 0.0017	<0.0019
Nickel, total	B 0.004	B 0.004	B 0.0086	B 0.0096	< 0.0017	B 0.0244	B 0.0201	B 0.0159	< 0.0017	<0.0019
pH	7.11	6.1	7.87	7.98	7.51	7.68	7.63	7.55	8.94	6.87
Potassium, dissolved	2.64	2.62	8.23	6.77	7.61	6.46	6.64	5.26	6.55	2.5
Potassium, total	B 2.74	B 2.64	10.5	9.07	8.32	11.6	10.8	8.42	6.93	2.71
Selenium, dissolved	< 0.0072	< 0.0072	< 0.0072	< 0.0072	< 0.0072	< 0.0072	< 0.0072	< 0.0072	< 0.0072	<0.00005
Selenium, total	< 0.0072	< 0.0072	< 0.0072	< 0.0072	< 0.0072	< 0.0072	< 0.0072	< 0.0072	< 0.0072	0.00051 B
Silver, dissolved	0.00056	0.00062	0.00051	0.00053	0.00038	0.00051	0.00053	< 0.0003	0.0006	<0.0008
Silver, total	B 0.00033	< 0.0003	B 0.00039	< 0.0003	< 0.0003	< 0.0003	<0.0003	< 0.0003	B 0.00038	<0.0008
Sodium, dissolved	11.9	8.94	0.478	0.45	1.86	0.957	0.984	1.89	0.485	12.5
Sodium, total	12.1	8.93	B 0.516	B 0.572	B 1.99	B 1.23	B 1.21	B 2.12	B 0.477	12.8
Thallium, dissolved	0.00043	0.00037	0.0007	< 0.0003	0.00057	0.0007	< 0.0003	0.00037	0.0005	<0.00002
Thallium, total	B 0.0003	--	< 0.0003	< 0.0003	< 0.0003	< 0.0003	< 0.0003	< 0.0003	B 0.00037	0.00042 B
TOC	3	3.1	6.6	5.8	11.1	4.6	4.4	5.1	12.5	10.2
Vanadium, dissolved	< 0.0002	< 0.0002	< 0.0002	0.00058	< 0.0002	0.0016	0.0014	0.00047	0.0011	0.002 B
Vanadium, total	B 0.00054	< 0.0002	B 0.0078	B 0.0075	B 0.00074	B 0.0215	B 0.0184	B 0.0122	B 0.0039	0.0022 B
Zinc, dissolved	0.0232	0.0403	0.002	0.0029	0.0018	0.0017	0.0012	0.0023	0.00073	<0.0004
Zinc, total	0.0229	0.0399	0.023	0.0231	B 0.0029	0.0541	0.0463	0.0328	0.0129	0.00056 B
AOC Identifier	U04-1139	U04-1140	U04-1143	U04-1144	U04-1145	U04-1146	--	U04-1147	U04-1148	U04-1253
Laboratory	SVL	SVL	SVL	SVL	SVL	SVL	SVL	SVL	SVL	--
Laboratory Identifier (total)	W429251	W429249	W429253	W429255	W429250	W429254	W429266	W429248	W429252	--
Laboratory Identifier (dissolved)	W429261	W429259	W429263	W429265	W429260	W429264	--	W429258	W429262	--

Notes:

(1) duplicate sample of SW-4

-- = not analyzed or not applicable

< = less than the Instrument Detection Limit

mg/L = milligrams per liter. Analytical results are presented in mg/L with the exception of pH (presented in pH units)

SVL = SVL Analytical, Inc. of Kellogg, Idaho

B = laboratory identifier for estimated value

NMAC = New Mexico Administrative Code

Table A-4 Results of Surface Water Samples Used in the S/TSIU Ecological Risk Assessment

Parameter	SW02 7/11/2006	SW03 7/11/2006	SW04 7/11/2006	SW05 7/12/2006	SW06 7/12/2006	SW07 7/13/2006	SW08 7/13/2006	SW09 7/14/2006	SW10 7/14/2006	SW11 7/17/2006	SW12 7/17/2006
Aluminum, dissolved	<0.0069	<0.0069	<0.0069	1.03	0.0273 B	<0.012	<0.012	<0.012	<0.012	0.0755	<0.012
Aluminum, total	0.0146 B	<0.0069	10.8	1.1	0.0337	0.0309	0.0201 B	0.0168 B	<0.012	8.08	13.9
Antimony, dissolved	<0.0055	<0.0055	<0.0055	<0.0055	<0.0055	<0.0025	<0.0025	<0.0025	<0.0025	<0.0025	<0.0025
Antimony, total	<0.0055	0.0062 B	<0.0055	<0.0055	<0.0055	<0.0025	<0.0025	<0.0025	<0.0025	<0.0025	<0.0025
Arsenic, dissolved	<0.0045	<0.0045	<0.0045	<0.0045	<0.0045	<0.0051	<0.0051	<0.0051	<0.0051	<0.0051	<0.0051
Arsenic, total	<0.0045	<0.0045	<0.0045	<0.0045	<0.0045	<0.0051	<0.0051	<0.0051	<0.0051	<0.0051	<0.0051
Barium, dissolved	0.0928	0.0752	0.0408	0.0615	0.0184	0.0306	0.0381	0.0581	0.0564	0.0332	0.0213
Barium, total	0.0975	0.0734	0.105	0.064	0.0186	0.031	0.0376	0.0575	0.0566	0.0724	0.0908
Beryllium, dissolved	<0.0002	<0.0002	<0.0002	0.0012 B	<0.0002	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
Beryllium, total	<0.0002	<0.0002	0.00046 B	0.0011 B	<0.0002	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	0.00059 B
Boron, dissolved	0.0097 B	0.0138 B	0.0162 B	<0.0084	<0.0084	0.0175 B	<0.0091	<0.0091	0.0118 B	<0.0091	0.0137 B
Boron, total	0.0118 B	0.0152 B	0.0195 B	<0.0084	<0.0084	0.0188 B	0.0107 B	<0.0091	0.0134 B	<0.0091	0.0192 B
Cadmium, dissolved	<0.0003	<0.0003	<0.0003	0.0014 B	<0.0003	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
Cadmium, total	<0.0003	<0.0003	0.0007 B	0.0011 B	<0.0003	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
Calcium, dissolved	71.8	61.7	19.7	73.9	8.21	20.1	33.8	30.1	20.7	14.2	12.7
Calcium, total	71	62.3	21.7	74.1	7.94	20.3	33.4	29.9	21.1	15.4	15.2
Chromium, dissolved	<0.0007	<0.0007	<0.0007	<0.0007	<0.0007	<0.0004	<0.0004	<0.0004	<0.0004	<0.0004	<0.0004
Chromium, total	<0.0007	<0.0007	0.0063	<0.0007	<0.0007	<0.0004	<0.0004	<0.0004	<0.0004	0.0039 B	0.0068
Cobalt, dissolved	0.00084 B	<0.0002	0.00039 B	0.0151	<0.0002	<0.0005	<0.0005	<0.0005	<0.0005	0.00065 B	<0.0005
Cobalt, total	0.00039 B	<0.0002	0.0023 B	0.0153	<0.0002	<0.0005	<0.0005	<0.0005	<0.0005	0.0018 B	0.0028 B
Copper, dissolved	0.005 B	0.0209	0.22	0.055	0.0197	0.0151	0.005 B	0.0091 B	0.0041 B	0.0487	0.0514
Copper, total	0.0094 B	0.0231	1.14	0.0613	0.0219	0.0178	0.0066 B	0.0107	0.0064 B	0.164	0.304
Iron, dissolved	0.0358 B	0.0018 B	0.005 B	0.0728	0.0087 B	<0.014	<0.014	0.0242 B	<0.014	0.0468 B	<0.014
Iron, total	0.112	0.0082 B	6.38	0.0817	0.0124 B	0.014 B	<0.014	0.0472 B	0.0193 B	5.34	9.79
Lead, dissolved	0.0028 B	<0.0015	0.002 B	0.003 B	0.0017 B	<0.0024	<0.0024	<0.0024	<0.0024	<0.0024	<0.0024
Lead, total	<0.0015	<0.0015	0.0166	0.0018 B	<0.0015	<0.0024	<0.0024	<0.0024	<0.0024	0.0057 B	0.0109
Magnesium, dissolved	18.4	16.6	1.13	39	4.89	9.7	16.4	13.2	8.96	1.44	1.29
Magnesium, total	18.4	16.8	2.74	39.6	4.76	9.57	16.1	12.4	8.94	2.57	3.45
Manganese, dissolved	0.216	0.0297	0.0464	1.65	<0.0008	<0.0009	<0.0009	0.0232	0.0118	0.0884	0.0282
Manganese, total	0.226	0.0292	0.149	1.67	0.001 B	0.0016 B	<0.0009	0.0265	0.0119	0.156	0.153
Mercury, dissolved	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Mercury, total	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Molybdenum, dissolved	0.0036 B	0.0053 B	0.0053 B	0.004 B	<0.0014	0.0036 B	<0.0017	<0.0017	<0.0017	0.0055 B	0.0068 B
Molybdenum, total	0.0058 B	0.007 B	0.0065 B	0.0052 B	0.0021 B	0.0038 B	0.0018 B	<0.0017	<0.0017	0.005 B	0.0056 B
Nickel, dissolved	<0.0019	<0.0019	0.002 B	0.039	<0.0019	<0.0026	<0.0026	<0.0026	<0.0026	<0.0026	<0.0026
Nickel, total	<0.0019	<0.0019	0.0043 B	0.0393	<0.0019	<0.0026	<0.0026	<0.0026	<0.0026	0.005 B	0.0072 B
pH	6.85	6.91	7.04	5.42	7.16	7.89	7.26	8.15	7.31	7.61	7.4
Potassium, dissolved	5.69	6.73	6.27	5.43	2.89	4.28	3.02	3.99	3.67	5.67	6.77
Potassium, total	6.01	6.84	8.82	5.8	3	4.33	3.06	3.78	3.64	7.26	9.88
Selenium, dissolved	0.0015 B	<0.00005	0.0008 B	0.00093 B	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005
Selenium, total	0.0013 B	<0.00005	0.0011 B	0.00076 B	<0.00005	0.00057 B	0.00072 B	<0.00005	<0.00005	0.00089 B	0.0012 B
Silver, dissolved	<0.0008	<0.0008	<0.0008	<0.0008	<0.0008	<0.0016	<0.0016	<0.0016	<0.0016	<0.0016	<0.0016
Silver, total	<0.0008	<0.0008	<0.0008	<0.0008	<0.0008	<0.0016	<0.0016	<0.0016	<0.0016	<0.0016	<0.0016
Sodium, dissolved	41.8	33.4	0.718	10.2	5.63	10.7	20	10.8	10.1	0.202 B	0.401 B
Sodium, total	43.7	34.1	0.867	10.8	5.72	10.8	20.1	10.4	10.2	0.317 B	0.566
Thallium, dissolved	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002
Thallium, total	0.00042 B	0.00057 B	0.00059 B	0.00042 B	0.00043 B	0.00038 B	0.00034 B	0.00046 B	0.00036 B	0.00042 B	0.00047 B
TOC	5	9.6	12.4	8.2	9.1	4.6	4	4.6	2.8	8	11.6
Vanadium, dissolved	0.0029 B	0.0035 B	0.0064	<0.0007	0.0016 B	0.0115	0.0141	0.0014 B	0.0017 B	0.0017 B	0.0015 B
Vanadium, total	0.0028 B	0.003 B	0.0142	<0.0007	0.0015 B	0.0115	0.0138	0.0013 B	0.0016 B	0.0064	0.0111
Zinc, dissolved	0.0015 B	0.0307	<0.0004	0.11	<0.0004	<0.0021	<0.0021	<0.0021	<0.0021	<0.0021	<0.0021
Zinc, total	0.002 B	0.0319	0.0552	0.112	0.00065 B	<0.0021	<0.0021	<0.0021	<0.0021	0.0163	0.0296
AOC Identifier	U04-1254	U04-1255	U04-1256	U04-1257	U04-1258	U04-1259	U04-1260	U04-1261	U04-1262	U04-1263	U04-1264
Laboratory	--	--	--	--	--	--	--	--	--	--	--
Laboratory Identifier (total)	--	--	--	--	--	--	--	--	--	--	--
Laboratory Identifier (dissolved)	--	--	--	--	--	--	--	--	--	--	--

Notes:

(1) duplicate sample of SW-4

-- = not analyzed or not applicable

< = less than the Instrument Detection Limit

mg/L = milligrams per liter. Analytical results are presented in mg/L with the exception of pH (presented in pH units)

SVL = SVL Analytical, Inc. of Kellogg, Idaho

B = laboratory identifier for estimated value

NMAC = New Mexico Administrative Code

Table A-4 Results of Surface Water Samples Used in the S/TSIU Ecological Risk Assessment

Parameter	SW13 7/17/2006	SW14 7/18/2006	SW15 7/18/2006	SW16 7/20/2006
Aluminum, dissolved	0.13	0.0202 B	<0.0069	<0.0069
Aluminum, total	27.9	2.09	5.57	0.101
Antimony, dissolved	<0.0025	<0.0055	<0.0055	<0.0055
Antimony, total	<0.0025	<0.0055	<0.0055	<0.0055
Arsenic, dissolved	<0.0051	<0.0045	<0.0045	<0.0045
Arsenic, total	<0.0051	<0.0045	<0.0045	<0.0045
Barium, dissolved	0.0276	0.0351	0.0254	0.0375
Barium, total	0.154	0.049	0.0503	0.038
Beryllium, dissolved	<0.0005	<0.0002	<0.0002	<0.0002
Beryllium, total	0.0017 B	<0.0002	0.00025 B	<0.0002
Boron, dissolved	0.01 B	0.0221 B	0.0216 B	<0.0084
Boron, total	0.0148 B	0.0223 B	0.0209 B	<0.0084
Cadmium, dissolved	<0.0002	0.00039 B	0.00031 B	<0.0003
Cadmium, total	<0.0002	<0.0003	<0.0003	<0.0003
Calcium, dissolved	15.7	7.64	12.7	171
Calcium, total	21.4	7.89	13.9	174
Chromium, dissolved	<0.0004	<0.0007	<0.0007	<0.0007
Chromium, total	0.0143	<0.0007	0.0029 B	<0.0007
Cobalt, dissolved	<0.0005	0.0025 B	0.0031 B	<0.0002
Cobalt, total	0.0045 B	0.0028 B	0.0045 B	<0.0002
Copper, dissolved	0.0495	0.0518	0.0721	0.0188
Copper, total	0.328	0.0866	0.204	0.0262
Iron, dissolved	0.067	0.203	0.0212 B	<0.0015
Iron, total	17.7	2.43	4.24	0.0815
Lead, dissolved	<0.0024	0.0037 B	0.002 B	0.0035 B
Lead, total	0.0157	0.002 B	0.0052 B	0.0036 B
Magnesium, dissolved	2.23	1.96	3.56	33.4
Magnesium, total	7.15	2.2	4.63	33.6
Manganese, dissolved	0.0609	0.661	0.536	<0.0008
Manganese, total	0.347	0.699	0.635	0.035
Mercury, dissolved	<0.0001	<0.0001	<0.0001	<0.0001
Mercury, total	<0.0001	<0.0001	<0.0001	<0.0001
Molybdenum, dissolved	0.0042 B	0.0091	0.0168	0.0097
Molybdenum, total	0.0025 B	0.01	0.016	0.0104
Nickel, dissolved	<0.0026	0.0032 B	0.0037 B	<0.0019
Nickel, total	0.012	0.003 B	0.0051 B	<0.0019
pH	7.48	6.64	5.56	8.96
Potassium, dissolved	7.91	6.66	5.88	4.77
Potassium, total	13.5	7.2	7.04	4.94
Selenium, dissolved	0.00061 B	<0.00005	0.00075 B	0.00058 B
Selenium, total	0.0021 B	0.00059 B	0.00092 B	0.00081 B
Silver, dissolved	<0.0016	<0.0008	<0.0008	<0.0008
Silver, total	<0.0016	<0.0008	<0.0008	<0.0008
Sodium, dissolved	1.41	0.985	1.95	20.2
Sodium, total	1.84	1.03	2.04	20.8
Thallium, dissolved	<0.00002	<0.00002	<0.00002	<0.00002
Thallium, total	0.00064 B	0.00037 B	0.00051 B	<0.00002
TOC	14.2	13.5	13.3	8.7
Vanadium, dissolved	0.004 B	<0.0007	0.0011 B	<0.0007
Vanadium, total	0.0235	0.0025 B	0.007	<0.0007
Zinc, dissolved	<0.0021	0.0024 B	<0.0004	<0.0004
Zinc, total	0.0515	0.0077 B	0.0112	0.0049 B
AOC Identifier	U04-1265	U04-1266	U04-1267	U04-1268
Laboratory	--	--	--	--
Laboratory Identifier (total) Laboratory Identifier (dissolved)	-- --	-- --	-- --	-- --

Notes:

(1) duplicate sample of SW-4

-- = not analyzed or not applicable

< = less than the Instrument Detection Limit

mg/L = milligrams per liter. Analytical results are presented in mg/L with the exception of pH (presented in pH units)

SVL = SVL Analytical, Inc. of Kellogg, Idaho

B = laboratory identifier for estimated value

NMAC = New Mexico Administrative Code

Table A-5 Results from Sediment Samples Used in the S/TSIU Ecological Risk Assessment

Parameter	A DRAINAGE#2 11/21/2004	B DRAINAGE#2 11/21/2004	C DRAINAGE#2 11/21/2004	D DRAINAGE#2 11/21/2004	BD1 11/20/2004	BD2 11/20/2004	BD3 11/20/2004	BD4 11/20/2004
Aluminum	12,900	8,920	5,730	8,830	3,990	7,480	2,980	4,320
Antimony	< 0.76	< 0.76	< 0.76	< 0.76	< 0.76	< 0.76	< 0.76	< 0.76
Arsenic	2.3	1.1	1.5	3.8	B 1.5	B 1.2	B 0.84	B 2
Barium	198	111	83.6	193	52.1	84	89.1	56.1
Beryllium	B 0.9	B 0.91	B 0.38	B 0.52	B 0.27	B 0.39	B 0.32	B 0.33
Boron	B 1.9	B 1.7	< 1.5	B 2.9	< 1.5	< 1.5	< 1.5	< 1.5
Cadmium	2.6	0.65	0.33	3.5	0.2	0.38	0.13	0.44
Calcium	8,220	5,620	1,870	95,100	B 877	2,750	B 850	B 708
Chromium	13.7	37.1	5.9	13.3	3.8	7.3	2.6	3.7
Cobalt	10.2	11	B 4.6	B 9	B 2.6	B 7.1	B 2.2	B 2.7
Copper	2,100	502	556	3,050	102	274	47	221
Iron	16,500	27,500	9,250	15,600	7,120	13,900	4,550	9,270
Lead	44.5	25.5	18.2	81	8.4	9.2	7.5	13.3
Magnesium	3,070	3,090	1,650	3,610	B 944	2,130	B 543	B 959
Manganese	574	480	195	332	169	314	315	178
Mercury	B 0.09	< 0.05	< 0.05	0.1	< 0.05	< 0.05	< 0.05	< 0.05
Molybdenum	8.7	3.4	6.3	11.6	1.5	3.5	1.2	3.1
Nickel	21.8	21.8	8.1	20.8	B 6.3	17.3	B 3.9	B 6
pH	7.25	6.82	6.37	7.5	B 6.25	7.63	B 6.62	B 7.06
Potassium	3,130	1,440	1,130	1,840	854	1,220	876	766
Selenium	B < 1.6	B < 0.16	B < 0.16	B < 1.6	< 0.16	< 0.16	< 0.16	< 0.16
Silver	B 0.67	B 0.61	B 0.31	B 0.96	B < 0.06	B < 0.06	B < 0.06	B < 0.06
Sodium	94.7	107	187	B 200	109	152	76.5	105
Thallium	< 0.74	< 0.74	< 0.74	1.1	< 0.74	< 0.74	< 0.74	< 0.74
TOC	2.1	0.32	0.33	1.76	0.09	0.18	0.03	0.07
Vanadium	25.1	92.3	18	27.2	16.3	26.7	11.2	20.5
Zinc	91.5	62.2	29.7	168	11.7	23.9	8.9	16.1
AOC Identifier	U04-1131	U04-1132	U04-1133	U04-1134	U04-1135	U04-1136	U04-1137	U04-1138
Laboratory	SVL	SVL	SVL	SVL	SVL	SVL	SVL	SVL
Laboratory Identifier	S429376	S429374	S429375	S429377	S429387	S429393	S429386	S429389

Notes:
(1) Duplicate sample. Duplicate sample follows the primary sample
-- = not analyzed or not applicable
< = less than the Method Detection Limit
mg/kg = milligrams per kilogram.
TOC = total organic carbon
SVL = SVL Analytical, Inc. of Kellogg, Idaho

Table A-5 Results from Sediment Samples Used in the S/TSIU Ecological Risk Assessment

Parameter	CDSWS-1 11/21/2004	LDS-1 11/20/2004	SWS-1 11/19/2004	SWS-2 11/19/2004	SWS-3 11/19/2004	SWS-4 11/19/2004	SWS-204(1) 11/19/2004	SWS-5 11/20/2004
Aluminum	4,240	5,960	5,280	4,770	3,980	19,500	B 21400	4,720
Antimony	< 0.76	< 0.76	< 0.76	< 0.76	< 0.76	< 0.76	< 0.76	< 0.76
Arsenic	B 2.1	B 1.1	B 1.2	B 2.1	B 0.92	B 1.4	B 1.6	B 0.96
Barium	53.7	86.8	119	70.1	41.3	212	B 216	40.4
Beryllium	B 0.4	B 0.36	B 0.39	B 0.35	B 0.24	1.4	B 1.4	B 0.34
Boron	< 1.5	< 1.5	< 1.5	< 1.5	< 1.5	< 1.5	B 2.3	< 1.5
Cadmium	0.09	0.12	0.13	0.08	0.05	0.25	B 0.25	0.16
Calcium	B 392	15,300	2,210	1,130	B 440	B 5650	5,990	B 940
Chromium	3.1	7.5	6.9	6.8	2.5	16.4	17.7	3.6
Cobalt	B 1.7	B 5.4	B 5.4	B 3.4	B 1.3	B 9.4	B 9.9	B 2.8
Copper	109	22	48	45	43	88	96	137
Iron	10,600	11,700	10,000	9,240	4,820	17,800	B 19200	5,410
Lead	15.7	9.2	11.3	10.4	4.9	18.6	B 20.1	7.6
Magnesium	B 993	2,710	1,480	B 933	B 821	3,840	B 4160	B 929
Manganese	149	318	334	282	145	760	B 812	169
Mercury	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	B 0.05	0.05	< 0.05
Molybdenum	3.1	1	B 0.83	B 0.95	B 0.88	1.6	1.8	1.8
Nickel	B 5.4	13.9	11.8	B 7.5	B 3.2	24.8	B 26.3	B 5.4
pH	B 7.29	B 7.98	7.84	6.91	B 5.82	6.77	6.85	B 5.14
Potassium	857	999	1,220	1,020	847	B 4890	5,250	897
Selenium	< 0.16	< 0.16	< 0.16	< 0.16	< 0.16	2.3	B < 0.8	< 0.16
Silver	B < 0.06	B < 0.06	B < 0.06	B < 0.06	B < 0.06	B < 0.06	B < 0.06	B < 0.06
Sodium	107	203	87.4	114	82	87.9	86	90.9
Thallium	< 0.74	< 0.74	< 0.74	< 0.74	< 0.74	< 0.74	B < 0.74	B < 0.74
TOC	0.03	0.07	0.11	0.07	0.05	1.06	B 0.96	0.29
Vanadium	26.7	26.3	21.4	23.9	10.8	23.5	25.1	9.2
Zinc	11.4	30.3	16.1	13.1	10	52	55.5	11.3
AOC Identifier	U04-1141	U04-1142	U04-1149	U04-1150	U04-1151	U04-1152	--	U04-1153
Laboratory	SVL	SVL	SVL	SVL	SVL	SVL	SVL	SVL
Laboratory Identifier	S429394	S429388	S429396	S429391	S429392	S429397	S429398	S429390

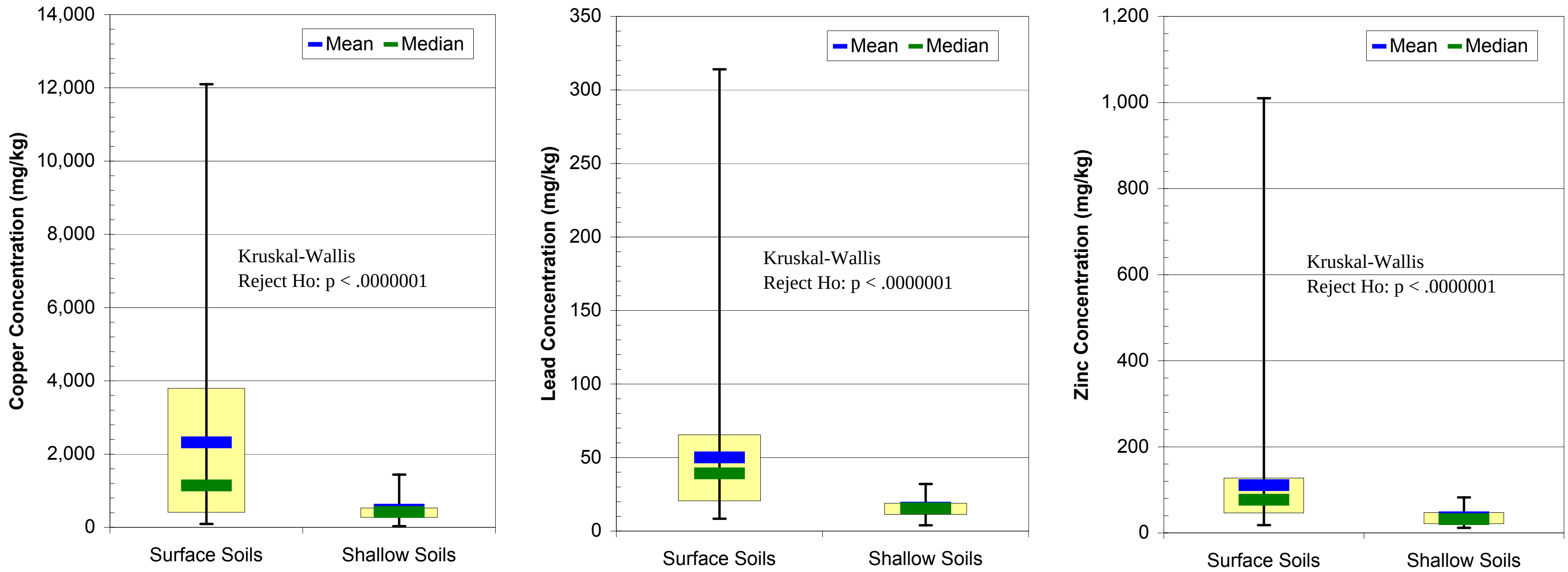
Notes:
(1) Duplicate sample. Duplicate sample follows the primary sample
-- = not analyzed or not applicable
< = less than the Method Detection Limit
mg/kg = milligrams per kilogram.
TOC = total organic carbon
SVL = SVL Analytical, Inc. of Kellogg, Idaho

Table A-5 Results from Sediment Samples Used in the S/TSIU Ecological Risk Assessment

Parameter	SWS-6 11/21/2004	SED01 7/11/2006	SED02 7/11/2006	SED03 7/11/2006	SED04 7/11/2006	SED05 7/12/2006	SED06 7/12/2006	SED07 7/13/2006	SED08 7/13/2006	SED09 7/14/2006	SED10 7/14/2006	SED11 7/20/2006
Aluminum	6,870	6580	4310	5450	5600	7590	5020	6150	4570	13900	6730	12400
Antimony	< 0.76	<0.58	<0.58	<0.58	<0.58	<0.58	<0.58	<0.58	<0.58	<0.58	<0.58	<0.58
Arsenic	B 1.6	1.2	0.74	0.9	2.1	1.5	0.82	0.42	0.45 B	2.8	0.72	0.97 B
Barium	118	77.2	48.5	69.9	102	75.9	59.5	73.4	57.6	180	73.1	182
Beryllium	B 0.41	0.47	0.33	0.48	0.47	0.49	0.23	0.3	0.27	0.87	0.5	0.55
Boron	< 1.5	<1.7	<1.7	<1.7	<1.7	<1.7	<1.7	<1.7	<1.7	<1.7	<1.7	<1.7
Cadmium	0.58	0.16	0.07	0.27	0.53	0.11	0.08	0.06	0.03	0.61	0.03	0.28 B
Calcium	7,800	1640	1360	2050	4650	1320	957	2480	2300	27900	2000	14200
Chromium	7.4	7.1	3	4.5	12.1	6.7	2.1	12.1	4.6	21.7	5.9	16
Cobalt	B 5	5.2	3.3	4.7	7.4	8.8	3.4	7.4	5.1	10	10.1	9.6
Copper	423	78	21.8	45.6	280	62.6	26.4	49.1	12.2	565	22.6	87.5
Iron	11,700	9920	7160	9890	27400	16200	7880	17200	9000	28400	15000	12800
Lead	20.4	10.2	7.4	20.8	20.8	10.5	7.3	7.2	3.4	23.1	7.5	10.9
Magnesium	2,170	1970	1390	1880	2130	1880	1640	2850	2240	3280	2310	4620
Manganese	337	332	195	339	448	348	177	263	199	426	349	418
Mercury	< 0.05	<0.017	<0.017	<0.017	<0.017	<0.017	<0.017	<0.017	<0.017	0.03 B	<0.017	<0.017
Molybdenum	3.4	1.4	0.48 B	1.1	3	1.2	0.71 B	0.7 B	0.43 B	4	0.78 B	1.4
Nickel	12.7	5	3.4	4	8.7	4.9	2.6	16.3	10.8	14	12	15.1
pH	8.03	6.17	6.74	7.38	8.24	5.92	5.89	7.38	6.59	7.89	6.09	7.52
Potassium	1,410	1120	846	1060	1340	1080	966	909	637	2300	858	2040
Selenium	< 0.16	0.2 B	0.11 B	0.28 B	0.34 B	0.21 B	0.15 B	0.05 B	0.2 B	<0.04	0.06 B	0.28
Silver	B < 0.06	<0.07	<0.07	<0.07	<0.07	<0.07	<0.07	<0.07	<0.07	<0.07	<0.07	<0.07
Sodium	123	115	132	168	58.4	130	119	214	224	58	171	332
Thallium	< 0.74	<0.35	<0.35	<0.35	<0.35	<0.35	<0.35	<0.35	<0.35	<0.35	<0.35	<0.35
TOC	0.26	0.53	0.09	0.08	0.07	0.28	0.08	0.05	0.09	1.19	0.1	<0.02
Vanadium	20.6	20.9	15.5	21.1	44.9	40.1	15	41.7	21.8	54.3	36.8	33.3
Zinc	43.4	22.1	35.9	82.3	51.7	23	19.2	22.6	13.5	63.4	18.9	65.4
AOC Identifier	U04-1154	U04-1242	U04-1243	U04-1244	U04-1245	U04-1246	U04-1247	U04-1248	U04-1249	U04-1250	U04-1251	U04-1252
Laboratory	SVL	--	--	--	--	--	--	--	--	--	--	--
Laboratory Identifier	S429395	--	--	--	--	--	--	--	--	--	--	--

Notes:
[1] Duplicate sample. Duplicate sample follows the primary sample
-- = not analyzed or not applicable
< = less than the Method Detection Limit
mg/kg = milligrams per kilogram.
TOC = total organic carbon
SVL = SVL Analytical, Inc. of Kellogg, Idaho

Figure A-1
Graphical Representation of Surface Soil (<200 um) and Shallow Soil (<2000 um) Data Collected in the ST IU RI (SRK, 2005)
Chino Mines Smelter/Tailing RI Ecological Risk Assessment



Error bars represent the minimum and maximum concentration measured.
Yellow Box represents the inter-quartile range (25th to 75th percentile)
Statistical comparisons made using the Kruskal-Wallis test (NCSS, 2004)

Kruskal-Wallis One-Way ANOVA on Ranks
Hypotheses
Ho: Medians are equal.
Ha: Medians are different.

APPENDIX B
Surface Water Hardness Calculations

Table B-1 - Calculation of Sample-Specific Hardness

Parameter	BD4W-1 11/20/2004	CDW-1 11/20/2004	SW-1 11/19/2004	SW-2 11/19/2004	SW-3 11/19/2004	SW-4 11/19/2004	SW-204[1] 11/19/2004
Calcium, total	19.3	15.2	26.3	22.9	7.41	19.4	19.5
Magnesium, total	4.94	3.51	3.52	3.68	1.94	6.33	5.52
Hardness (Calculated)	68.5	52.4	80.2	72.3	26.5	74.5	71.4

Parameter	SW-5 11/20/2004	SW-6 11/21/2004	SW-01 7/11/2006	SW-02 7/11/2006	SW-03 7/11/2006	SW-04 7/11/2006	SW-05 7/12/2006	SW-06 7/12/2006
Calcium, total	14.4	33.4	16.6	71	61.7	21.7	73.9	7.94
Magnesium, total	6.49	2.91	6.84	18.4	16.6	1.13	39.6	4.89
Hardness (Calculated)	62.7	95.4	69.6	253.1	222.4	58.8	347.6	40.0

Parameter	SW-07 7/13/2006	SW-08 7/13/2006	SW-09 7/14/2006	SW-10 7/14/2006	SW-11 7/17/2006	SW-12 7/17/2006	SW-13 7/17/2006	SW-14 7/18/2006
Calcium, total	20.3	33.4	29.9	20.7	15.4	15.2	21.4	7.64
Magnesium, total	9.57	16.4	12.4	8.96	2.57	3.45	7.15	1.96
Hardness (Calculated)	90.1	150.9	125.7	88.6	49.0	52.2	82.9	27.1

Parameter	SW-15 7/18/2006	SW-16 7/20/2006
Calcium, total	12.7	171
Magnesium, total	3.56	33.6
Hardness (Calculated)	46.4	565.4

Hardness calculated using the formula: Hardness = 2.497*(Ca) + 4.118 * Mg